Broilers, Dairy Cattle, Fed Beef Cattle, Layers and Swine: Differences Between Actual Production and Production with an "Optimum" Economic Utilization of Feed in Eleven Regions of the United States, 1965

By

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Abstract of Dissertation Presented to the Graduate Council
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Doctor of Philosophy

BROILERS, DAIRY CATTLE, FED BEEF CATTLE, LAYERS, AND SWINE: DIFFERENCES BETWEEN ACTUAL PRODUCTION AND PRODUCTION WITH AN "OPTIMUM" ECONOMIC UTILIZATION OF FEED IN ELEVEN REGIONS OF THE UNITED STATES, 1965

By

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June, 1970

Chairman: Professor W. K. McPherson
Major Department: Agricultural Economics

In this study a linear programming model was developed to allocate the 1965 supply of livestock feedstuffs to the broilers, layers, hogs, beef cattle, and dairy cattle produced in each of eleven regions of the country during that year. The allocation was based on the least-cost formulation of diets that met nutritional requirements established by the National Research Council. The feedstuff supply was first allocated to each class of animals independently and then to the five classes simultaneously. The cost and composition of the independent and simultaneous formulations of the diet for each class of animal in every region were compared. An effort was made to determine the "optimum" location to produce the five classes of animals on the basis of the cost of the least-cost formulation of diets by an iterative procedure, using the simultaneous formulation model.

The cost of the least-cost formulation of the diets was higher when the feedstuffs were allocated among classes of animals simultaneously than when allocated independently. This was due to the competition for the aggregate supply of nutrients among the five classes of livestock. The

nutrient supply is [illegible] differing quantities of nutrients such that [illegible] with the cheapest source of the limiting nutrient [illegible] first. In general, the indigenous feedstuffs were the cheapest source of nutrients, and the costs of diets increased as alternative sources had to be found to furnish the required amounts of the limiting nutrients.

Diet costs were relatively high in regions in which the supply of nutrients was not sufficient to produce the quantity of livestock products consumed. To the extent that locally produced feedstuffs were available, livestock producers in deficit feedstuffs producing areas appeared to have an advantage over producers in surplus feedstuffs producing regions for the market in these regions. Once the local supplies of feedstuffs were utilized the cost of the diet increased rapidly in the deficit feedstuffs producing regions.

The average of the costs of diets as determined by four iterations of the model gave an estimate of feed cost for each class of animals by regions from which the feed cost difference equivalent of the transportation rate (FDCETR) could be calculated. The location of broiler production was significantly out of phase with the transportation rate (TR) and FDCETR method of orienting production. This suggests that in 1965 any large scale expansion of the broiler industry would have occurred outside of the two major producing regions. The expansion would have most likely occurred in the three Midwestern regions. Egg and milk production was market oriented in location, and expansion of the industry at that time would have been dependent upon size of the market within each region. Pork producers faced a general situation of being neither market nor feed producing region oriented due to the TR and

Those differences being [illegible].

The production of fed beef [illegible] in comparing the TR's and FCDs [illegible]. However, the cost of the fed beef diet tended to be more sensitive to the [illegible] of the local feed supplies than the cost of the hog [illegible]. To the extent to which fed beef production was market [illegible] appeared to depend upon the quantity of locally produced feed [illegible] in consumption areas

In general, the hypothesis, that livestock and livestock products were being produced in areas where the cost of shipping a unit of product from the production region to the consuming region was less than the difference in the cost of the diet between the two regions used to produce the unit of product, was found to be true. However, the hypothesis was refuted in the case of broilers and, to a lesser extent, fed beef

The influence of alternative public policies on cost of livestock diets in different regions can be estimated by the use of this model. More specifically, it is now possible to quantitively evaluate such policies as (1) increasing the price on a commodity of commodities, (2) changing levels of production of various feedstuffs (3) the effect of new feedstuffs or nutrient sources of livestock production, (4) a simultaneous price and volume change of one or several feedstuffs, (5) economic impact of changing the nutrient levels of certain feedstuffs, i.e., increasing lysine content of corn

The simultaneous least-cost formulation model of the five diets in eleven regions can be expanded to k diets and n regions. In addition, this model can be used in a comprehensive spatial equilibrium or simult[illegible] sub-sect[illegible] economy. By utilizing [illegible] to the [illegible]tions that are frequently made [illegible] partial equilibrium [illegible] be avoided

INTRODUCTION

> A maximum national product is forthcoming from given resources only as mobile resources (capital and labor) are applied to immobile resources (land) in a geographic pattern which allows the greatest economic product to each unit of mobile resource (12, p. 639).

In the livestock feed sub-sector of the national economy, feed stuffs are produced on the immobile resource, land, in the form of grains, oilseeds, grass and legume roughages, and other feedstuffs. These feedstuffs are converted into consumer goods, i.e., meat, eggs, and milk by livestock and poultry. The harvesting of a feedstuff is accomplished either mechanically or by animals. In the production of milk, poultry products, and the higher grades of pork and beef, feedstuffs are harvested by machines and then fed to animals whose individual movements are confined to a small area. Once feedstuffs are detached from the land and move freely in the channels of commerce, they become mobile resources.

Because of the differences in the physical environment, enterprises specializing in the production of specific feedstuffs have a certain advantage over enterprises specializing in the production of other crops in certain geographic areas. On the other hand, most livestock products are consumed by people who live largely in densely populated areas often located hundreds and even thousands of miles from where feedstuffs are produced. At the present, little correlation exists between the geographic location of feedstuff production and the consumption of livestock products. A regional comparison of the number of people (consumers of livestock products) and the production of broilers, eggs, fed beef, milk, and pork for eleven regions of the United States is given by the percentages in Figure 1

The location in which each type of feedstuff can be economically produced is unique to a crop but often extends into several states. Corn, for example, is produced in all the Continental states with the bulk of the production being in the Midwestern states. Oats are grown in the cool-season northern border states, and wheat in the drier areas of the Great Plains and Western plateaus. Grain sorghum, a crop of importance only since World War II, is produced in the irrigated regions of the Southwest. The oil seed meals, which are joint products of the vegetable oil industry, are grown in distinct regions with little overlap. Soybeans are grown throughout the corn belt and the Mississippi River Valley. Cotton is produced in the Southern states, peanuts in the Southeast, and flaxseed in the upper Great Lakes area. Animal protein feedstuffs are processed wherever livestock and poultry are slaughtered. Feedstuffs from marine sources are produced in the Coastal areas. A new dimension has been added since 1960 -- synthetic nutrients, the production of which is not tied to a physical environment per se but to a manufacturing plant. In the short run, plant location is fixed but becomes mobile in the long run, whereas the physical environment is relatively permanent.

In recent years, technological advances in transportation have reduced the cost of shipping both feedstuffs and livestock products. To the extent that this has reduced the cost of assembling feedstuffs and the cost of the shipment of meat, it has increased the number of locations in which livestock may be profitably produced. This trend has been

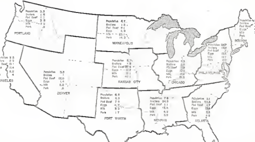

Figure 1 Distribution of Population, Production of Broilers, Eggs, Fed Beef, Milk, and Pork, by Region, 1965

accelerated by the [illegible] nutritionists

For years [illegible] requiring detailed information on the amount of each [illegible] to produce specific quantities of livestock and livestock products. Nutrient requirements are now expressed in terms of the quantity of energy, protein, amino acids, vitamins, minerals, fat, fiber, etc., diets must contain. Animals can retrieve nutrients from plant sources, animal by-product feedstuffs, and in some instances synthesized chemical compounds. Feedstuffs differ in the kind and amount of nutrients made available to animals for meeting their nutrient requirements. Physiological differences in digestive systems cause the retrieval rate of the same nutrient from a feedstuff to be different for the various classes and weights of animals. Furthermore, physiological differences in the digestive systems of the various classes of animals result in different rates of conversion for the same combination of feedstuffs to the finished product. Consequently, producers now evaluate feedstuffs on the basis of their ability to make nutrients available to animals rather than as components of a feed mixture.

Where home grown feedstuffs are available, the feed formulation problem is simply to find feedstuffs which will combine with the home grown feedstuffs to satisfy the animals' nutrient requirements. This in turn limits the number of alternatives available. On the other hand, the specialized livestock producers have a large number of alternatives in that a large number of feedstuffs are available in the market.

Because the advantages of specialization are becoming more apparent, many farmers now produce feed grains exclusively, while others specialize

In the feeding of [illegible] [illegible] of foodstuff sold [illegible]

The structure and/ [illegible] of livestock and poultry production has changed dramatically over the [illegible] and particularly within the last 15 years. Broiler production once concentrated near major population centers has moved to more distant production areas, particularly the Southeastern states and the lower Mississippi Valley states. The scale of operations has expanded, and the control of production has passed on to the integrated processors. Commercial egg enterprises have replaced the farm flocks as the major source of eggs and a shift in producing regions is underway. The production of fed beef is expanding on the periphery of the grain producing regions and in the South, Southwest, and Far West; Pork and milk production has remained within the same geographic location but is being restructured within the region. Large investments in capital facilities are frequently needed to obtain the economies of specialization, but large investments, once made, limit the opportunity of the producer to change enterprises or locations.

Once feedstuffs have been detached from the land, they become mobile resources that can be used in any location at prices that include the costs of assembly and transportation from one location to another. Feedstuffs can be divided into two classes based on the ratio of transportation cost to total value. A 'mobile feedstuff' is one in which the cost of transportation is a small percentage of the total value; Whereas, an "immobile feedstuff" is one for which transportation cost is a high percentage of its total value; 'Mobile feedstuffs" are those which are traded in relatively large quantities such as grains, oilseed meals, by-product feeds, and molasses "Immobile feedstuffs" are generally the [illegible] haylages, and grain [illegible] on farms where produced — [illegible] cannot be economically transported over [illegible]. [illegible] mobile feedstuff [illegible] producing region [illegible] the production of a limited number of animals [illegible] that can be produced with the quantity of the [illegible] supply.

The most desirable location for livestock feeding enterprises [illegible] those locations in which the costs of assembling feedstuffs and [illegible] and the costs of distributing finished products are the lowest. An important aspect in the location of broiler, egg, fed beef, [illegible], and pork producing enterprises is the relationship between the costs of shipping intermediate livestock products and the difference in the cost of comparable feed mixtures between deficit and surplus [illegible] areas.

In the nation, as a whole, essentially all of the feedstuff supply is fed to livestock and poultry, and the supply of livestock and poultry products is consumed for a given time period. However, this is not true in a sub-area or region of the country. In surplus feedstuff production areas, feedstuff production exceeds the amount needed to satisfy the demand for livestock products in that area and the converse is true in deficit feedstuff producing areas. Since each feedstuff contains different quantities of nutrients and the individual diets require varying amounts of nutrients, an allocation problem arises as to which class(es) of animals can most efficiently utilize the regional nutrient supply. Also, the mobile supply of nutrients can be transported between regions for conversion to a consumer product or they may be converted to a consumer product in the area in which they are grown. Inasmuch as the location of the feedstuff production area is fixed by the physical [illegible] and the [illegible] is dictated by the consumer, [illegible] simply "will the [illegible] of meat, eggs, and milk be located at the [illegible] of consumption, [illegible] the feedstuff production area, or at some point intermediate to the two?"

Objective of Study

This study has two basic purposes: (1) to determine the "optimum" allocation of the 1965 feed supply between the five classes of live stock in eleven regions and (2) to show the relationship between the cost of shipping a unit of livestock product from surplus to deficit production areas, and the difference in the cost of the diet required to produce the same unit of product between regions.

Hypothesis

The hypothesis is that livestock products will tend to be produced in locations for which (1) the cost of shipping a unit of eggs, milk, poultry and meat from a surplus production region to the consumption location is less than (2) the difference in the cost of the diet required to produce the unit of livestock product between the area of production and the area of consumption.

LITERATURE REVIEW

The review of [illegible] the literature related to the theory of location of economic activity and that related to the applications of location theory to the livestock-feed sector of the United States economy.

Economic Theory

Since Adam Smith's advancement of the theory of absolute advantage (to which Ricardo added the principle of comparative costs) and Von Thunen's development of the theory of the isolated state, many books have been written on trade and the location of industry. The earlier writers were mainly cost oriented, while the latter ones were demand and equilibrium oriented. Because of the complexities of the problem and the number of variables involved, most researchers have studied sub-sectors of the problem rather than the problems as a whole.

The first attempt to formulate a general theory of location is attributed to Alfred Weber (36). Based on historical observations, Weber formulated an evolutionary theory of spatial development from a purely agricultural to an industrially advanced economy. The innovation in Weber's works was that industrial location was seen as functionally related to transport cost, wages, and what he terms agglomeration and deglomeration. Agglomeration is described as the marketing advantages offered by internal and external economies of size, while deglomeration represents the disadvantages of high site [illegible]. Using these concepts, [illegible] substitution analysis of transfer and non transfer costs [illegible] the location of industry. Weber's analysis stimulated [illegible] of economists to attack the intricate problems of space and location.

Both Weber and Von Thunen were oriented toward cost as the overriding determinant of location. They assumed demands for production to be fixed with no interdependence existing between the product market area, the location of processing facilities, and the supply area of factors.

Losch (19) introduced the concept that the market area of a firm contributed to its location. His system of hexagonal market areas is known to most students of location theory. However, his method of analysis does not incorporate many cost variables and his analysis is not strong with regard to the interdependence of firms. The hexagons are the result of assuming a homogeneous distribution of the product demands and factor supplies, and once one hexagon is known all the rest can be easily determined.

More comprehensive coverage of all variables has been attempted by Lefeber (18) and Isard (14). Their efforts tied together into a uniform theory all of the area, transport and traditional variables, along with certain general variables, such as the number of factors or products, and welfare. The work of Dunn (7), who showed how to integrate agriculture and industry location theory, should also be noted.

Miller and King (22) have summarized the important variables used in location theory and analysis. These variables are shown in Table 1. The area variables are those associated with the physical attributes of the geographic area under study. The physical transportation

Table 1.--The Major Variables Analyzed in Location Theory

Area	Variables			
1. Size of factor supply area	1. The transport network	1. Nonmonetary preferences of producers for particular sites	1. Economies of size a. Factors b. Products	1. Number a. Factors b. Products
2. Location of factor supply area	2. Supply of transportation services	2. Nonmonetary preferences at sites for producers	2. Indivisibility a. Factors b. Products	2. Time
3. Size of factor demand area	3. Demand for transportation services	3. Public policy of regulation on factors and products	3. Demand a. Factors b. Products	3. Uncertainty
4. Location of factor demand area			4. External economies a. Factors b. Products	4. [illegible]
5. Size of product supply area			5. Supply a. Factors b. Products	
6. Location of product supply area			6. Rent a. Factors b. Products	
7. Size of product demand area				
8. Location of product demand area				
9. Location and number of possible sites for use in production or consumption				

Source: (23, p. 7)

activ[illegible] co[illegible] the transportation [illegible]. The non-qu[illegible] variables are [illegible] on the choice of location plus public policy. The traditional variables [illegible] economic considerations [illegible] size, demand, supply, rent, etc. Under the generality column are the variables external to the firm, such as time, uncertainty, and welfare. Miller and King point out that the methodology used to study a spatial problem differs according to the importance attached to each variable. The list may be modified, but anyone investigating a particular problem should recognize the importance of the variables he may choose to exclude.

A comprehensive review of literature and the relevant economic theory for solving spatial problems appears in a collection of papers presented at a workshop on Interregional Competition sponsored by the Southern Farm Management Research Committee (35).

Plant Location in the Livestock-Feed Sector

Numerous studies have been made in the areas of the feed and livestock sectors of the United States agricultural economy. The scope of these studies varies from the simple one-product models of production, and allocation. A problem common to all studies was how to combine the numerous feedstuffs into diets for given classes of livestock or poultry. Additional problems were created with the multi-product models where n feedstuffs were formulated into n diets for k regions. The diet problem has been handled in several ways, three of which are: (1) the typical diet, i.e., using a common diet in all regions composed of the same feedstuffs, (2) animal units -- where feed consumption for all classes is reduced to a common denominator by establishing the intake of nutrients of one class as the base and (3) classifying all feedstuffs as being either protein, energy or roughage feeds and assuming each ci[illegible]

One of the first [illegible] in the livestock feed sector using a spatial equilibrium model was that of Fox (8). Feed production and livestock numbers were taken as given, and, assuming demand for feed to be functionally related to variables in the livestock sector, an equilibrium solution for regional feed prices and feed consumption was found. The model was then shown as a means to evaluate policy measures in the feed-livestock sector. The model was extended by Fox and Taubman (9) in a later article to yield a simultaneous price equilibrium for feed and livestock.

Judge and Wallace (16) applied the Samuelson spatial price equilibrium model in a 21-region, single-product analysis for beef and pork. Equilibrium prices and quantities were determined by a parametric and iterative process based on price dependent regional demand functions for beef and pork.

Williams and Dietrich (39) were primarily concerned with demand differences, transportation costs, slaughter facilities, and wage rates. These factors contribute significantly to the location of the feeding enterprise, but they ignored two spatially oriented factors of production -- feeder cattle and feed. This study confirmed that location and transportation costs are important determinants of competitive market power in interregional fed beef commerce. They showed the Central Corn Belt and the Northern plains to have a locational advantage over the Northeast. Location gives the Southern plains competitive advantage over the East, Southcentral, and Southeastern areas.

The handling of feed inputs was a problem in a regional study of intersectoral relations by Iski and Schreiner, using a Leontief input-output analysis. Maki and Schreiner state

> One of the [illegible] [illegible] study was that of est[illegible] [illegible] [illegible] the li[illegible] stock sec[illegible] [illegible] [illegible] data [illegible] available f[illegible] [illegible] [illegible] of feed [illegible] by years [illegible] [illegible] [illegible] by states or regions (20, p. 23).

A linear programming model was used by the Joint [illegible] [illegible] and Meat Committee ([illegible]) — from which three papers (11, 15, 21) were published to determine the "optimum" location of production, level of slaughtering cattle and hogs, and the optimal interregional flows of livestock and meat. The objective of the study was to find (1) the level and location of the slaughter of each type of livestock, and (2) the volume and direction of livestock and meat flows that minimize aggregate transport and slaughtering costs. The supplies of slaughter animals were taken as given by regions.

In a simulation study Crom (6) concluded that, from the viewpoint of transportation cost, additional cattle production could be expanded in the Southeast at the least additional cost." Feed cost was not incorporated into the study. The South is a deficit feedstuff producing area and it is likely that an expansion of livestock and poultry production would cause higher per unit feed costs.

One of the more advanced spatial equilibrium models for location of cattle feeding is that of Schrader (30). In this model of the regional location of fed beef production, they assumed as given regional feeder cattle and feed supplies, nonfeed costs of feedlot operations, feed conversion ratios by region, regional demand, and transfer cost functions.

However, King pointed out that one of the weaknesses of the study was the assumption that the beef sector was independent of the other livestock production.

> Th[illegible] for industrial use, and ot[illegible] and for [illegible] other th[illegible] feed [illegible] as given [illegible] This is a limiting assumption. [illegible] that the production of produc[illegible] hogs in the Corn Belt and dairy products in the Lake States are given with no adjustment possibilities traced through. Although it would be possible to include such alternatives, this model concentrates on one aspect of the feed-livestock complex. In the following approach, it has been possible to trace through the effect of alternative specifications of the model. From the viewpoint of an analysis of comparative advantage among regions in the production of livestock products, the approach leaves much to be desired (17, p. 97).

Cheang and Judge (5), in a study of the livestock feed eco[illegible] grouped feeds into the following general classes (1) feed gra[illegible] (2) high protein feeds, (3) animal protein feeds, (4) grain pro[illegible] feeds, (5) medium protein feed and (6) low protein feeds. Livestock was classified as grain consuming and grain and roughage consuming. The unit for measuring feed consumption was animal units. It was assumed that x pounds of a given feedstuff would have the same nutrients as ax pounds of another. This was a very strong assumption. Compare the analyses of soybean oil meal and dried brewers grains which are shown in Table 2. The ratio of protein and gross energy in soybean meal is $\frac{45.8}{4198}$ which is not equal to the protein and energy ratio of $\frac{25.9}{4644}$ for brewers grains. The difficulty lies in determining how feedstuffs of varying nutrient ratios may be reduced to a common denominator. Furthermore, the same feedstuff has different energy values, for each class of animals. For example, the metabolizable energy values for soybean meal for ruminants, swine, and poultry are 2,639, 2,712, and 2,244 kilo calories per kilogram respectively.

Table 2. -- Composition of Soybean Oil Meal and Dried Brewers Grains.

Feed name or analysis		Soybean meal Mean as fed	Brewers grains Mean as fed
Dry matter	%	89.0	92.0
Ash	%	5.8	3.6
Crude fiber	%	6.0	15.0
Ether extract	%	.9	6.2
Protein (Nx6.25)	%	45.8	25.9
Protein, dig., rum	%	42.1	20.7
Energy, gross	kcal/kg	4198.	4646.
Energy, dig., rum	kcal/kg	3212.	2640.
Energy, dig., swine	kcal/kg	3300.	1892.
Energy, metab., rum.	kcal/kg	2638.	2163.
Energy, metab., swine	kcal/kg	2712.	1550.
Energy, metab., poultry	kcal/kg	2244.	
TDN, rum	%	73	60
TDN, swine	%	75	43.
Calcium	%	.32	.27
Iron	%	.01	.03
Magnesium	%	.27	.14
Phosphorus	%	.67	.50
Potassium	%	1.97	.08
Sodium	%	.34	.26
Cobalt	mg/kg	.1	.1
Copper	mg/kg	36.3	21.3
Manganese	mg/kg	27.5	37.6
Choline	mg/kg	2743.4	
Folic acid	mg/kg	7	
Niacin	mg/kg	26.8	
Pantothenic acid	mg/kg	14.5	
Riboflavin	mg/kg	3.3	
Thiamine	mg/kg	6.6	
Arginine	%	3.20	1.30
Histidine	%	1.10	.50
Isoleucine	%	2.50	1.50
Leucine	%	3.40	2.30
Lysine	%	2.90	.90
Methionine	%	.60	.40
Phenylalanine	%	2.20	1.30
Threonine	%	1.70	.90
Tryptophan	%	.60	.40
Tyrosine	%	1.40	1.20
Valine	%	2.40	1.60

National Academy of Sciences - National Research Council, Feed Composition, Publication Number 1232, Washington, D. C., 1964

Another diff[illegible] some [illegible] results from the fact that r[illegible] amino acids and utilize nonprotein nitrogen so[illegible] mono-gastric animals must have the essential amino acids. In formulating diets, nutritionists prefer to use productive energy for poultry, [illegible] metabolizable energy for swine, and net energy for ruminants.

The feed cost problem forces rigid assumptions on the part of researchers in studying the livestock-feed sector. Richards and Korzan (28), in studying the feasibility of commercial feedlots in Oregon, concluded that an expansion of the feeding industry could profitably take place. Three of their assumptions were: (1) feed cost is based on a fixed formulation of the diet over a 96 month period; (2) other classes of livestock do not exceed production; (3) the cost of the diet varies, but only downwards in explaining what happens with lower feed costs. The probability that the same diet formulation would be fed over a 96 month period with the cost of the diet decreasing as production increase is small. Alice and D[illegible] (1) showed that Oregon was in a feed deficit area during the period of this study.

Harlow (10) acknowledged that variations in feed cost were a major factor influencing the number of hogs produced. However, rather than using the cost of feed, he used the corn hog ratio as the feed variable in his study. His conclusion was that, "Under present conditions with ample corn supplies and prices supported under the price-support program, the ratio is no longer as reliable an indicator as formerly" (10, p. 1). An examination of the feed price indexes (1957 59=100) showed that in 1955 the feed grain index was 113 and the index of eleven high protein feeds was 96. In 1962, the indexes were 99 and 122 respectively for feed grains and high protein feeds.

[illegible] the cattle and hog sectors [illegible] (3). The objective [illegible] the regional level of production of two final commodities, [illegible] and pork, and interregional flows and internal prices of intermediate [illegible] final goods. The regional supplies of primary intermediate commodities, feed grains, protein feeds, roughages, feeder cattle, and the regional demands for the final goods were given. The model accounted for changes in other livestock products through other variables. Essentially, a systems approach was used and the major components of the livestock-feed sectors were utilized within the constraint of the computing equipment available, input data, time, and the course of a doctoral dissertation.

Bucholz, following the example of other authors, simplified the nutrition problem with some very strong assumptions. His abstraction of the nutrition problem is summarized by his statement --

> The two main categories of feed are concentrate feeds and roughages. Actually, there is a third category: feed additives, such as minerals, vitamins, antibiotics and hormones. In the present context these are of minor importance, however, and will not be considered further. Feed concentrates include feed grains and protein feeds. The distinction of feed grains and protein feeds is necessary because of differences in feeding value. Feed grains are rich in carbohydrates and are best used for fattening animals. Protein feeds are better utilized by growing animals.
>
> (3, p. 11)

McPherson and Witt (21) studied the feed cost relationship between the Midwest and Florida using "optimum" nutrient specifications for each class of livestock to obtain the least-cost diet in each region. However, the five classes of livestock studied were considered independent of each actual [illegible] feed grains. In the study the feed supply was not [illegible]. Indigenous feeds were shown in the diets, but [illegible] has been placed on their use the cost of the optimum [illegible] would have increased.

The study utilized a standard set of nutrient specifications, given by Florida Agricultural Experiment Station nutritionists, which were assumed to give equal feed efficiency in the two areas. A least-cost diet using local prices was formulated from locally available feedstuffs. The use of linear programming in formulating the diet eliminated the assumption of equal nutrient ratios in feedstuffs.

In summary, the objectives of the various studies of the livestock-feed sector of the national economy were met. In abstracting from the real world, priorities had to be assigned to each component of the sector by the investigator, with most making an aggregate analysis of the feed sector and a detailed analysis of the livestock sector. For the large multi-product, multi-regional models to become meaningful, a detailed look needs to be taken at the utilization of the feed supply and diet formulation. This is especially true in light of the differences in the nutritional requirements of each class of livestock, and the new feedstuffs which have become available to the producer. Ideally, a detailed analysis of both the livestock and feed sectors should be made concurrently in order to develop a meaningful model.

METHODOLOGY

The approach to this study differs from the approaches used in earlier studies in the following respects. It is based on the fact that: (1) animal diets are stated in terms of the quantities of specific nutrients required by an animal; (2) these nutrients are available from a wide variety of materials, commonly called feedstuffs or feed ingredients; and (3) livestock producers strive to feed the combination of feedstuffs that will provide nutrients specified in the diet at the lowest possible cost.

To accomplish the objective, a linear programming model was developed to minimize the total cost of feed required to satisfy the dietary requirements of animals needed to produce the broilers, eggs, fed beef, milk, and pork supplied from eleven regions of the United States in 1965. This model was then used: (1) to determine the cost of the least-cost formulation of each of the five diets in eleven regions of the nation independently of its impact on the demand for feedstuffs generated by other classes of livestock within the constraints imposed by the 1965 feedstuff supply, (2) to determine the costs of the least-cost formulations of the five diets in the same eleven regions simultaneously, and (3) along with an iterative procedure, to equate the costs of transporting a product between regions with the difference in the costs of the least cost formulations between the same regions.

This analysis of the relationship between the cost of shipping a product from production to consumption areas and the difference between [illegible] the [illegible] the [illegible] [illegible] a partial [illegible]. However, [illegible] cost of feed is the [illegible] in the pr[illegible] [illegible] broilers, [illegible] fed beef, milk, and pork.

This chapter is organized in the follo[illegible]: (1) nutr[illegible] specifications for the five diets and [illegible] the [illegible] by regions, (2) quantity and types of f[illegible] by [illegible], (3) nutrient composition of feedstuffs, (4) [illegible] (5) the model to formulate least-cost diets for each class of animals, (6) [illegible] to formulate the five diets simultaneously, (7) consumption estimate of the five livestock and poultry products by regions, (8) reallocati[illegible] model, (9) iterative procedure, (10) determining the optimum location of production.

Nutritive Specifications for Diets

The nutritive specifications for the broiler finisher, layer, steer finisher, 20 percent dairy, and hog finisher diets were essentially those used by McPherson and Witt (22). Slight modifications in the diets were based on the recommendations of animal nutritionists. These modifications were in the form of constraints on certain feedstuffs and an increase in the level of urea that could be used in the ruminant diets. The nutritive specifications followed closely the recommendations of the National Research Council (26). The nutritive specifications of the diets are shown in Tables 3, 4, and 5. These diets, while based on the recommendations of nutritionists, are theoretical diets which should give specific rates of production but they have not been fed to animals to verify the rate at which the feed mixture is converted to livestock products.

[illegible] 3. -Nutri[illegible] the [illegible]ler and Lay[illegible]

REQUIRE[illegible]	[illegible]	[illegible]	L[illegible]
Minimum Product[illegible]	Meg Cal/lb.	1.000	900
Minimum Arginine	%	1.030	.500
Minimum Lysine	%	1.030	.625
Minimum Methionine	%	.380	.299
Minimum Methionine [illegible]	%	.725	.503
Minimum Tryptophan	%	.185	.148
Minimum Glycine	%	.800	.200
Maximum Crude Fiber	%	4.000	6.000
Minimum Calcium	%	.800	2.750
Minimum Available Phosphorus	%	.400	.400
Minimum Niacin	Mg/lb.	20.000	15.000
Minimum Pantothenic Acid	Mg/lb	6.500	3.000
Minimum Vitamin B_{12}	Mg/lb.	4.000	5.000
Minimum Choline	Gm/lb	.650	450
Minimum Vitamin A Activity	Thousand IU/lb	.300	.400
Minimum Synthetic Vitamin [illegible]	Thousand IU/lb.	1.500	2.000
Minimum Xanthophyll	Gm/lb	.300	800
Minimum Added Fat	%	1.000	---
Maximum Added Fat	%	15.000	15.000
Trace Mineral Mix	%	.150	.100
Salt	%	.400	.350
Maximum Cottonseed Meal 41%	%	5.000	---
Maximum Meat Meal	%	5.000	10.000
Maximum Poultry by-product Meal	%	5.000	5.000
Maximum Feather Meal	%	2.500	2.500
Maximum Fish Meal	%	7.500	5.000
Maximum Fish Solubles	%	3.000	3.000
Maximum Molasses, Cane	%	5.000	5.000
Minimum Alfalfa Meal 17%	%	---	2.500
Minimum Corn	%	10.000	10.000
Minimum Riboflavin	Mg/lb	2.500	1.600

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[a] These diets have not been tested but were based upon the recommendations of poultry scientists, Fla. Agric. Exp. Station.

Table 4.—Nutrient Specifications and Feedstuff Restrictions for the Hog Diet[a]

REQUIREMENT	UNIT	HOG FINISHER
Minimum Metabolizable Energy	Meg Cal/lb.	1.300
Minimum Crude Protein	%	13.000
Maximum Crude Protein	%	17.000
Minimum Lysine	%	.660
Minimum Methionine	%	.220
Minimum Methionine plus Cystine	%	.440
Minimum Trypthophan	%	.110
Maximum Crude Fiber	%	5.000
Minimum Calcium	%	.480
Maximum Calcium	%	.800
Minimum Total Phosphorus	%	.440
Maximum Total Phosphorus	%	.650
Minimum Niacin	Mg/lb.	5.000
Minimum Riboflavin	Mg/lb.	1.000
Minimum Pantothenic Acid	Mg/lb.	4.500
Minimum Vitamin B_{12}	Mcg/lb.	5.000
Minimum Vitamin A Activity	Thousand IU/lb.	.150
Salt	%	.500
Maximum Added Fat	%	10.000
Trace Mineral Mix	%	.100
Maximum Cottonseed Meal 41%	%	10.000
Maximum Linseed Meal	%	5.000
Maximum Peanut Meal	%	10.000
Maximum Coconut Meal	%	5.000
Maximum Meat Meal	%	5.000
Maximum Blood Meal	%	3.000
Maximum Poultry by-product Meal	%	5.000
Maximum Feather Meal	%	5.000
Maximum Fish Meal	%	7.500
Maximum Fish Solubles	%	2.500
Maximum Corn Gluten Meal	%	5.000
Maximum Corn Gluten Feed	%	20.000
Maximum Yellow Hominy	%	20.000
Maximum Rice Bran	%	20.000
Maximum Dried Whey	%	5.000
Maximum Molasses, Cane	%	5.000
Maximum Brewers Dried grains	%	10.000
Maximum Distillers Dried grains	%	10.000
Maximum Brewers yeast	%	5.000
Maximum Wheat Middlings	%	20.000
Maximum Alfalfa Meal	%	2.500

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[a] This diet has not been tested but was based on the recommendations of swine nutritionists, Fla. Agric. Exp. Station.

Table 5.—Nutrient Specifications and Ingredient Restrictions for the Steer Finisher and 20 Percent Florida Dairy Diets[a]

REQUIREMENTS	UNIT	STEER FINISHER	DAIRY 20%
Minimum Net Energy	Meg Cal/lb.	.680	.740
Minimum Crude Protein	%	11.500	20.000
Minimum Digestible Protein	%	9.000	----
Minimum Crude Fiber	%	8.000	8.000
Maximum Crude Fiber	%	12.000	12.000
Minimum Calcium	%	.500	.300
Maximum Calcium	%	.900	.700
Minimum Total Phosphorus	%	.300	.400
Maximum Total Phosphorus	%	.500	.600
Minimum Synthetic Vitamin A	Thousand IU/lb.	3.000	2.000
Maximum Added Fat	%	5.000	4.000
Salt (Trace Mineral)	%	.500	1.000
Maximum Corn Gluten Feed	%	----	25.000
Maximum Rice Bran	%	35.000	35.000
Maximum Molasses, Cane	%	15.000	10.000
Maximum Citrus Pulp	%	50.000	33.000
Maximum Urea	%	1.750	2.000
Maximum Wheat Middlings	%	40.000	35.000

[a] These diets have not been tested but were based on the recommendations of ruminant nutritionists, Fla. Agric. Exp. Station.

The Amount of Feed Required by Regions

The amount of each of the diets needed to produce the 1965 supply of broilers, eggs, fed beef, milk, and pork in the eleven regions was estimated by multiplying the amount of a given diet to produce a unit of product (conversion factors in Table 6) times the regional production of that product (Appendix Tables 2,3,4,5, and 6). Table 7 shows the total quantity of each diet required to feed the broilers, layers, beef cattle, dairy cattle and hogs who produced the broilers, eggs, fed beef, milk and pork in each of the eleven regions in 1965.

A constant ratio of the conversion of feed to product was assumed for all regions. The model could easily have accommodated different feed conversion ratios. However, sufficient reliable data by regions were not available, and this factor could not be incorporated at the time. Amick and Purcell (2) have shown that the "optimum" feed efficiency in swine is 60°F and that efficiency drops rapidly below 45° and above 80°F. Interest is great on the part of animal scientists in the area of climatic factors affecting feed conversion, especially temperature and humidity.

Feedstuffs

The feedstuffs included in this study were the common ingredients in which sufficient quantities were available for feeding and for which an established price system was in effect. Many locally significant feedstuffs were excluded because of the lack of adequate prices, because the quantities available for feeding were not known or because the local supply was insignificant for any major expansion of livestock production;

TABLE 6.—[illegible]
Selected Livestock Products

Livestock Product	Form	Feed [illegible] 100 Pounds of Product	Weight of Product shipped as Percent of Product on Animal
		pounds	percent
Milk	Bulk	40.5[a]	100
Eggs	Fresh	255.0[b]	100
Broilers	Carcass (ice pack)	280.0[c]	75
Beef	Carcass	400.0[d]	60
Pork	Carcass	377.0[e]	70

[a] $\frac{405 \text{ lbs. feed/lb. of milk} \times 100}{}$ = 40.5 feed/100 lbs. of milk (4% butter fat, body maintenance met from other sources).

[b] $\frac{4.0 \text{ lbs. feed/dozen eggs} \times 30 \text{ dozen} \times 100}{47 \text{ (weight of 30 dozen cases)}}$ = 255 lbs feed/100 lbs. eggs.

[c] $\frac{2.1 \text{ lbs. feed/lb. of broiler} \times 100}{75 \text{ (dressing per cent)}}$ = 280 lbs. feed/100 lbs. dressed broiler.

[d] $\frac{8.0 \text{ lbs. feed/lb. grain in feedlot} \times 300 \text{ lbs. grain} \times 100}{1{,}000 \text{ (liveweight)} \times 60 \text{ (dressing per cent)}}$ = 400 lbs. feed/100 lbs. of carcass (assuming 700 lbs. feed cattle of comparable quality are available in all areas)

[e] $\frac{3.3 \text{ lbs. feed/lb. of grain} \times 160 \text{ lbs. gain from feed} \times 100}{200 \text{ (liveweight)} \times 70 \text{ (dressing per cent)}}$ = 377 lbs. feed/100 lbs. of carcass (assuming 40 lb. feeder pigs of comparable quality are available in all areas).

Source: (21, p. 25)

Table 7.—The Total Amount of Feed Required by Class of Livestock and Regions, 1965 (Mill[illegible]

Region	Broilers[a]	Layers[b]	Pork[c]	Beef[d]	Dairy[e]	Total
Boston	715,314	932,000	112,122	002,400[f]	1 837,115	[illegible]
Philadelphia	2 733,722	2 894,769	1 051,578	278,400	9 448,650	16 407,119
Chicago	320,282	2 895,768	16 793,577	4 999,200	8 372,970	33 381,797
Kansas City	238,316	2 369,961	21 528,879	15 748,800	5 100,975	44 986,931
Minneapolis	193,550	1 912,066	7 714,836	3 828,000	13 201,785	26 850,257
Portland	262,796	686,979	506,379	2 126,400	1 960,200	5 542,754
Los Angeles	454,876	2 669,328	218,232	5 476,800	3 437,640	12 256,876
Denver	020,896	310,356	332,433	5 049,600	1 090,465	6 803,750
Ft. Worth	1 026,740	1 009,656	920,730	3 345,600	1 760,130	8 062,856
Memphis	5 968,894	2 877,120	2 105,433	446,400	2 470,500	13 868,347
Total	16 177,902	21 441,803	53 778,402	41 983,200	50 579,640	183 960,[illegible]

[a] Broilers Total pounds broilers (live weight) produced per region x 2.1 pounds

[b] Layers Total eggs produced per region x 333 pounds

[c] Pork Total pounds pork marketed (live weight) per region x 2.64 pounds.

[d] Fed Beef Total head per region x 2400 pounds.

[e] Milk Total pounds milk produced per region x .405 pounds.

[f] Assumes 1,000 head of cattle fed.

Examples of feed [illegible] areas, were corn [illegible] date) and citrus [illegible] supply).

Nutrient [illegible] of Feed[illegible]

The nutrient com[illegible] feedstuff [illegible] in Appendix Table 7. The primary [illegible] the National Academy of Sciences (25), [illegible] (24), and Spencer Morrison (23).

Quantity of Feeds[illegible] ion by Livestock

The supply of feed[illegible] consumption by livestock in 1965 was divided [illegible] (1) [illegible] between regions and (2) immobile. The mobile [illegible] comprised of all grain fed to livestock but not [illegible] produced, millfeeds, animal by-products feeds, [illegible] molasses, and other by-product feeds. Immobile [illegible] fed to livestock on farms where produced and/or feeds such [illegible] and silages, not readily transportable between regions. Table 8 [illegible] the 1965 supply of feedstuffs available for consumption by livesto[illegible] in each of the eleven regions of the nation.

The quantities of the mobile grains were estimated by subtracting the quantity of the grain fed to livestock on farms where produced from the total quantity of the grain fed to livestock. The immobile supply of each grain was the quantity used for feed and seed on farms where grown.

Table 8.--Supply of Feedstuffs Available for Livestock Consumption During 1965 (Billion Pounds)

Feedstuff	1965 Supply Pounds	Feedstuff	1965 Supply Pounds	Feedstuff	1965 Suppl, Pounds
Mobile Feedstuff					
Soybean Meal[a]	20.62400	Beet Pulp[a]	2.40000	608 Corn, Farm	.39000
Cottonseed Meal[a]	5.06600	Brewers Grains[a]	.61000	609 Corn, Farm	.74000
Linseed Meal[a]	.56800	Distillers Grains[a]	.87000	610 Corn, Farm	5.28000
Peanut Meal[a]	.21600	Brewers Yeast[a]	.10000	611 Corn, Farm	6.19200
Coconut Meal[a]	.21800	Citrus Pulp[h]	.64832	601 Barley, Farm[k]	.00000
Meat Meal	3.17980	Urea 262% protein equiv.	Open[1]	602 Barley, Farm	.63600
Tankage[a]	.68400	DL Methionine	Open	603 Barley, Farm	.17000
Blood Meal[a]	.20000	Lysine	Open	604 Barley, Farm	[illegible]
Poultry-by-Poultry Meal[a]	.30000	Vitamin A	Open	605 Barley, Farm	[illegible]
Feather Meal[a]	.20000	Riboflavin	Open	606 Barley, Farm	[illegible]
Animal Fat[a]	.85000	Pantothenic Acid	Open	607 Barley, Farm	[illegible]
Fish Meal[a]	.85820	Niacin	Open	608 Barley, Farm	[illegible]
Fish Solubles[a]	.36780	Choline Chloride	Open	609 Barley, Farm	[illegible]
Corn Gluten Meal[a]	1.30520	Vitamin B_{12}	Open	610 Barley, Farm	[illegible]
Corn Gluten Meal[a]	1.50760	Calcium carbonate	Open	611 Barley, Farm	[illegible]
Hominy Feed[a]	1.48000	Deflourinated phosphate	Open	601 Oats, Farm[1]	[illegible]
Wheat Bran[a]	6.30040	Soft Rock phosphate	Open	602 Oats, Farm	[illegible]
Wheat Middlings[a]	3.23120	Dicalcium phosphate	Open	603 Oats, Farm	[illegible]
Oat Feed[a]	.36400	Limestone	Open	604 Oats, Farm	[illegible]
Rice Bran[a]	.79000	Salt and trace minerals	Open	605 Oats, Farm	[illegible]
Corn FOB[b]	71.63200		Open	606 Oats, Farm	[illegible]
Barley FOB[c]	5.11000	Immobile Feedstuff		607 Oats, Farm	[illegible]
Oats, FOB[d]	8.89600	601 Corn, Farm[j]	.01600	608 Oats, Farm	[illegible]
Milo FOB[e]	22.28800	602 Corn, Farm	3.01600	609 Oats, Farm	[illegible]
Wheat FOB[f]	.90000	603 Corn, Farm	39.33600	610 Oats, Farm	.20000
Skim Milk[a]	.36000	604 Corn, Farm	44.35000	611 Oats, Farm	.34200
Whey[a]	.36000	605 Corn, Farm	18.86600	601 Milo, Farm[m]	
Cane Molasses[g]	3.93792	606 Corn, Farm	.12800	602 Milo, Farm	.01800
Alfalfa Meal[a]	3.35000	607 Corn, Farm	.03800	603 Milo, Farm	.04600

Table 8 --"Continued"

Feedstuff	1965 Supply Pounds	Feedstuff	1965 Supply Pounds	Feedstuff	1965 Supply Pounds
604 Milo, Farm	5.88200	607 Alfalfa Hay	12.87200	610 Grass Hay	4.63200
605 Milo, Farm	.38400	608 Alfalfa Hay	13.08800	611 Grass Hay	[illegible]
606 Milo, Farm	.00000	609 Alfalfa Hay	3.45900	601 Corn Silage[f]	[illegible]
607 Milo, Farm	.14600	610 Alfalfa Hay	1.09400	602 Corn Silage	28.[illegible]
608 Milo, Farm	.49900	611 Alfalfa Hay	.14800	603 Corn Silage	26.01400
609 Milo, Farm	1.99200	601 Clover-Grass Hay[d]	2.42800	604 Corn Silage	27.51400
610 Milo, Farm	.07400	602 Clover-Grass Hay	10.17200	605 Corn Silage	58.32600
611 Milo, Farm	.08200	603 Clover-Grass Hay	8.90000	606 Corn Silage	4.57200
601 Wheat, Farm[c]	.00000	604 Clover-Grass Hay	6.75200	607 Corn Silage	2.406[illegible]
602 Wheat, Farm	.44000	605 Clover-Grass Hay	4.26000	608 Corn Silage	7.935[illegible]
603 Wheat, Farm	.56400	606 Clover-Grass Hay	2.84000	609 Corn Silage	1.007[illegible]
604 Wheat, Farm	.59200	607 Clover-Grass Hay	1.36600	610 Corn Silage	3.33[illegible]
605 Wheat, Farm	.38600	608 Clover-Grass Hay	1.36600	611 Corn Silage	4.44400
606 Wheat, Farm	.62000	609 Clover-Grass Hay	.00000	601 Sorghum Silage[g]	.00000
607 Wheat, Farm	.00400	610 Clover-Grass Hay	1.43200	602 Sorghum Silage	.04000
608 Wheat, Farm	.12800	611 Clover-Grass Hay	.46000	603 Sorghum Silage	14.54200
609 Wheat, Farm	.19600	601 Grass Hay[e]	.75600	604 Sorghum Silage	14.54200
610 Wheat, Farm	.09400	602 Grass Hay	2.19200	605 Sorghum Silage	1.22800
611 Wheat, Farm	.01400	603 Grass Hay	1.23400	606 Sorghum Silage	.00000
601 Alfalfa Hay[b]	.88200	604 Grass Hay	6.70400	607 Sorghum Silage	.67600
602 Alfalfa Hay	10.53000	605 Grass Hay	7.48200	608 Sorghum Silage	1.57200
603 Alfalfa Hay	20.48800	606 Grass Hay	1.10200	609 Sorghum Silage	3.34800
604 Alfalfa Hay	32.14600	607 Grass Hay	.79400	610 Sorghum Silage	1.56800
605 Alfalfa Hay	37.28000	608 Grass Hay	2.07600	611 Sorghum Silage	.70200
606 Alfalfa Hay	15.41600	609 Grass Hay	5.07600		

[a] Letter to R G Witt from Mr. Malcolm Clough, Feed Section, Economic and Statistical Analysis Division, Economic Research Service, U.S. Department of Agriculture. Mr. Clough provided these data in advance of publication of the 1966 Feed Statistics (Stat. Bul. 410) of his section. These were preliminary estimates and were subject to change prior to publication.

[b] FOB-Corn-(mobile supply) The difference between the quantity utilized as livestock feed (32, p. 35) which is a residual after all other uses of the corn supply as been accounted for but

Table 8 --"Notes Continued"

includes some minor uses and wastes and the quantity used as feed and seed as farm grown, p. 34.

[c] FOB Barley - same as Corn (32, p. 48).

[d] FOB Oats - same as Corn (32, p. 42).

[e] FOB Milo - same as FOB Corn (32, p. 57)

[f] Farm Wheat - same as Farm Corn (32, p. 7)

[g] Citrus-Pulp - Florida Canners Association 1965 Annual Summary.

[h] Cane Molasses - U. S. Department of Agriculture Consumer and Marketing Service, 1965 Annual Summary.

[i] Ingredients are assumed to have an unlimited supply in all regions.

[j] Farm Corn (immobile supply by regions)- Quantity used for feed and seed on farms where grown. Data not adjusted for amount used for seed, since most seed corn is hybrid and must be purchased from commercial sources (32, p. 34).

[k] Farm Barley - same as Farm Corn (32, p. 47).

[l] Farm Oats - same as Farm Corn (32, p. 41).

[m] Farm Milo - Same as Farm Corn (32, p. 55).

[n] FOB Wheat - same as FOB Corn (32, p. 9).

[o] Alfalfa Hay - (32, p. 274).

[p] Clover-grass Hay - (32, p. 274).

[q] Grass Hay - Listed as other hay in United States Department of Agriculture, Statistical Reporting Service 1965 Annual Crop Summary December, 1965.

[r] Corn Silage - (32, p. 31).

[s] Sorghum Silage - (32, p. 54)

Prices of Feedstuffs

The prices of feed ingredients were obtained from the following sources: (1) Grain Market News, (2) Feedstuff Market News, (3) Feedstuffs, (4) Molasses Market News, (5) knowledgeable people, (6) author's synthesis. Appendix Table 8 shows the prices and their sources which were used in this study.

The 1965 seasonal average price was used when available. The simple average weekly price was calculated for ingredients when Feedstuffs was used as the source of prices. Insufficient data were available to calculate a weighted annual average price of these ingredients.

Prices were synthesized for ingredients in cases where: (1) price data were available in one or more but not all regions, or (2) the ingredient did not have an established cash market, namely silages. When prices were not available in all regions the synthesized price was based on the price for the feedstuff in a region with published price. The synthesized price for a feedstuff in a region was the lowest total of the published price plus transportation cost from regions with published prices to the region without a published price. Silage prices were based on the price of hay and grain as shown in Appendix Tables 9 and 10.

It was assumed that (1) the F O B. bulk carlot price quoted on each of the eleven markets was the competitive market price for a feedstuff, and (2) price differences between markets were due to transportation costs, assembly costs, and added cost for handling a given ingredient. The value of feeds fed on farm was assumed to be equal to the farm price. The most commonly used grade of feed was used when several grades were quoted.

The Linear Programming Model

The linear programming model [illegible] formulation of the five diets in the eleven regions was developed from the matrix of the coefficients for formulating each of the five diets. The concept for this model was to associate each coefficient with a particular diet and region. Thus, complete identification of any coefficient in the programming matrix refers to the row (constraint), column (feedstuff), diet, and region. For example, a_{ij}, in the simple diet problem, was the quantity of the ith nutrient contained in one unit of the jth feedstuff. In the model to solve the minimum cost of feeding the animals to produce the 1965 supply of broilers, eggs, fed beef, milk, and pork, this notation was supplemented by superscripts k and g, which denote diet and region respectively. Each coefficient was identified as a_{ij}^{kg}, the amount of the ith nutrient contained in the jth feedstuff for the kth diet in the gth region.

Following this notation, a feedstuff or ingredient for any single diet was expressed as X_j. To identify the feedstuff X_j with a particular diet and region, the superscripts k and g were added to give X_j^{kg} ($j = 1, \ldots, n$, $k = 1, \ldots, 5$, $g = 1, \ldots, 11$). Likewise, nutrient specifications and the constraints on the use of certain feedstuffs were indicated by r_i^{kg} when the reference was made to the ith nutrient specification or constraint in the kth diet for the gth region. The prices of feedstuffs were denoted as c_j^{kg}, which represented the price of the jth feedstuff of the kth diet in the gth region. The price of the jth feedstuff in the gth region, however, was the same for the five diets so that $c_j^{1g} = c_j^{2g} = \ldots = c_j^{5g}$

In addit[illegible] to the [illegible] constraints [illegible] on the utiliz[illegible] equal to or le[illegible]. These supply constr[illegible] feedstuff [illegible] between region[illegible] le betw[illegible]. The [illegible] m_j's ($j = 1, \ldots, 34$) [illegible] supply constrai[illegible] feedstuffs [illegible] m_j^g ($j = 35, \ldots, 44$, $g = 1, \ldots, 11$) are the supply constr[illegible] feedstuffs which apply only to the hog, steer, and dairy [illegible] $\frac{1g}{j}$ s for $j = 45, \ldots, 59$ refer to synthesized feedstuffs [illegible] there were no constraints on supplies.

Using this notation [illegible] row of the model becomes:

$$r_1^{11} \geq a_{11}^{11}X_1^{11} + a_{12}^{11}X_2^{11} + \ldots + a_{1j}^{11}X_j^{11} + \ldots + a_{159}^{11}X_{59}^{11}$$

In general, the ith con[illegible] diet in the gth region would be

$$r_i^{kg} \lesseqgtr \sum_{j=1}^{59} a_{ij}^{kg}X_j^{kg} \text{ for } i = 1, \ldots, r_k;\ k = 1, \ldots, 5,\ g = 1, \ldots, 11.$$

The Independent Diet For[illegible]

The linear programming model used to formulate the diet for each of five classes of animals for the nation was as follows

$$\text{Minimize } Z = \sum_{g=1}^{11} \sum_{j=1}^{59} C_j^g X_j^g$$

Subject to nutritive constraints on the diets

$$r_i^g \lesseqgtr \sum_{j=1}^{59} a_{ij}^g X_j^g,\ i = 1, \ldots, m_k,\ g = 1, \ldots, 11,$$

to the constraints on the "mobile feedstuff" supply

$$\sum_{g=1}^{11} X_j^g \leq m_j,\ j = 1, \ldots, 34;$$

to constraints on the "immobile feedstuff" supply

$\sum_{k=1}^{3} X_j^{kg} \leq s_j^g$, $g = 1, \ldots, 11$; $j = 35, \ldots, 44$, $k = 1, 2, 3$ for hog, steer, and dairy diets, and to $X_j^g \geq 0$ for all g and j.

The Simultaneous Diet Formulation Model

The model for the simultaneous diet formulation can be written as:

$$\text{Minimize } Z = \sum_{k=1}^{5} \sum_{g=1}^{11} \sum_{j=1}^{59} C_j^{kg} X_j^{kg}$$

Subject to nutritive constraints on the diets

$r_i^{kg} \lessgtr \sum_{j=1}^{59} a_{ij}^{kg} X_j^{kg}$, $i = 1, \ldots, m_k$, $k=1, \ldots, 5$, $g = 1, \ldots, 11$

to the constraints on the "mobile feedstuff" supply

$\sum_{k=1}^{5} \sum_{g=1}^{11} X_j^{kg} \leq m_j$, $j = 1, \ldots, 34$

to constraints on the "immobile feedstuff" supply

$\sum_{k=1}^{3} \sum_{g=1}^{11} X_j^{kg} \leq s_j^g$, $j = 35, \ldots, 44$, $g = 1, \ldots, 11$

and to $X_j^{kg} \geq 0$ for all j, k, and g.

Computer Program for Solving the Least Cost Formulations

The computer program used was the Mathematical Programming System-360 (MPS-360) (13) furnished by International Business Machines Corp. The use of the MPS Program required the following assumptions: (1) all prices, matrix elements and right hand side elements were known with certainty, (2) all relationships between vectors were linear, and (3) column vectors were independent and additive. The objective function that was minimized was the minimum aggregate cost for the five diets in the eleven regions.

Consumpti[illegible]

The quantit of each of t[illegible] in each region was estimated by mult[illegible] [illegible] estimated [illegible] consumption times the population in th[illegible]. Per capita co[illegible] estimates are shown in Table 9 and the [illegible] quantity of each product consumed during 1965 is shown in T[illegible]le 10

Per Capita Consumption Estimates - The basic model for estimating regional per capita consumption was derived by Raunikar *et al* (27), from the Atlanta Panel Study Variables considered in making estimates were race, age, income, and place of residence (rural or urban) The assumption was made that consumers in other regions would have the same tastes and preferences as Atlantans for these products. Some merits of the Atlanta Study are (1) a detailed record of purchases by members of the panel was kept for a period of 5 years, (2) the range of annual incomes (up to $12,000) was adequate, (3) the study included all types of meat, meat products, poultry, eggs, fish, and seafood.

Regional estimates of per capita consumption were made for each of the livestock products using the variable shown in Appendix Table 11. These regional estimates were weighted to obtain an aggregate per capita consumption estimate.

The regional estimates of per capita consumption were adjusted for the difference between the estimated per capita consumption in the U.S. and the actual per capita consumption (34, p. 15). This adjustment was made by multiplying the ratio of the two consumption estimates by the regional estimates.

Table 9 --Per Capita Consumption Estimates of [illegible] Products for 1965 (Pounds)

Region	Broilers	Shell Eggs	Fed Beef	Fresh Milk	Pork
Boston	27.7	28.9	64.1	330	56.2
Philadelphia	31.1	32.8	67.3	278	60.4
Chicago	29.1	29.5	65.1	317	58.0
Kansas City	28.0	31.4	61.4	304	59.0
Minneapolis	26.6	28.8	60.5	332	56.3
Portland	29.1	33.1	64.6	289	60.0
Los Angeles	29.2	27.9	66.8	259	55.8
Denver	26.8	28.5	61.1	262	54.4
Ft. Worth	28.5	30.2	61.3	254	60.0
Memphis	29.7	28.5	56.3	225	60.6
Atlanta	29.9	28.8	58.0	208	60.0
U S.	29.4	30.2	63.6	281	58.7

Source: Estimates were derived from data published by Baumlker et al. (27, pp. 31, 33, 35, 38, and 41) after adjusting for actual consumption in 1965. Data on actual consumption were obtained from the U.S.D.A. (34, p. 15)

Table 10 --Estimated Consumption of Broilers, Eggs, Fed Beef, Milk, and Pork by Regions, 1965 (Million Pounds)

Region	Broilers	Shell Eggs	Fed Beef	Fresh Milk	Pork
Boston	309	322	714	3,678	626
Philadelphia	1,480	1,561	3,203	13,230	2,874
Chicago	1,085	1,000	2,427	11,816	2,163
Kansas City	281	344	672	3,328	650
Minneapolis	240	260	807	2,748	533
Portland	184	209	407	1,823	378
Los Angeles	537	513	1,229	5,318	1,027
Denver	169	179	385	1,650	343
Ft. Worth	374	394	799	3,332	782
Memphis	450	432	853	3,408	918
Atlanta	528	509	1,025	3,676	1,060
Total	5,639	5,823	12,521	54,007	11,354

Est[illegible] capita consumption were the si[illegible] average of Raun[illegible] the method [illegible] of [illegible] (31, p 19) Th[illegible] favorabl[illegible] to the regional consumption [illegible] reported [illegible] survey. Table 11 shows [illegible] on of the [illegible]

To obtain an estimate of the per capita consumption of [illegible], the per capita consumption of beef was multiplied by 64.4 percent. This percentage represents the proportion of total beef production that was classified as fed beef (33, p 34). It was assumed that consumers in each region consumed the same ratio of fed beef to non-fed beef.

The per capita consumption of fresh milk was the weighted per capita estimates in the Federal milk marketing order areas in each region. Consumers residing in the region outside of the marketing order areas were considered to have the same consumption as those in the order areas.

The total estimated consumption of each product was calculated by multiplying the per capita estimates in Table 8 by the population of each region, Appendix Table 1. The estimated regional consumption of the product was rounded to the nearest million pounds.

Transportation Costs

Transportation costs were obtained for each of the five products based on the most common mode of transport. Tariffs published by the Interstate Commerce Commission (ICC) were used when applicable. One of the difficulties arising from using ICC tariffs was the difference in the minimum weights of the shipments which ranged from 21,000 and

Table 11 - Comparison of [illegible] Consumption Estimates by Regions for Beef and Pork, Adjust[illegible]5 Actual Consumption Pounds

	BEEF				PORK		
	Raunikar[a] et al.	Stout[b] et al.	Aver. Two Meth.	Adjusted Average	Raunikar	Stout	Average Two Meth.
Boston	95.5	103.6	99.5	100.1	53.9	58.4	56.2
Philadelphia	106.8	102.2	104.5	105.1	62.9	57.9	60.4
Chicago	102.2	100.0	101.1	101.7	56.9	59.1	58.0
Kansas City	95.1	95.5	95.3	95.9	59.3	58.6	59.0
Minneapolis	91.5	96.3	93.9	94.5	54.1	58.4	56.3
Portland	102.6	98.0	100.3	100.9	62.0	57.9	60.0
Los Angeles	100.4	107.2	103.8	104.4	52.0	59.5	55.8
Denver	88.4	101.4	94.9	95.5	51.5	57.2	54.4
Ft. Worth	90.8	99.7	95.2	95.8	60.6	59.3	60.0
Memphis	86.1	88.8	87.4	87.9	61.6	59.6	60.6
Atlanta	89.8	90.3	90.0	90.5	60.8	59.1	60.0
Weighted Average	99.3	99.3	98.7	99.3	58.7	58.7	58.7

[a] Raunikar et al. (27, p. 21).

[b] Stout et al. (31, p. 19).

90,000 pounds. Tariffs applying to the larger cars were published only between the origins and destinations of large shipments. The rates for each class of livestock product are discussed separately.

Broiler Carcasses

The rates for ice packed dressed poultry carcasses were furnished by USDA and Southern Railway System from published ICC tariffs. Appendix Table 12 shows the appropriate tariff, size of car, and source between eleven origins and destinations. The size of car ranged from 21,000 to 90,000 pounds.

Rates from Los Angeles to Memphis and Atlanta were $4.33 and $7.57 per 100 pounds respectively for a 21,000 pound car, whereas, from Portland to these two destinations the rates were $1.51 and $2.32 respectively for a 60,000 pound car. To make the rates between these regions consistent with other regions the Portland rate was used between Los Angeles and Memphis and Los Angeles and Atlanta.

Fresh Meat Carcasses

The rates for pork and beef carcasses were generated by a system developed by the Economic Research Service of USDA of estimating transportation cost as a function of distance. This system was based on a one percent sample of waybills in 1965 for both rail and truck. Using the waybills to estimate the cost parameters a computer program was devised for computing the transportation cost from the map coordinates of the origin and destination. Appendix Tables 14 and 15 show the transportation costs estimated by this procedure.

Eggs

Transportation [illegible] for [illegible] and were based on refrigerated rail cars as a mode of [illegible]. Appendix Table 16 shows the transportation costs of eggs.

Milk

Weisenborn's (37, p. 28) estimate of the cost of transporting milk was 16 cents per 100 pounds per 100 miles times the shortest highway mileage between the origin and destination divided by 100. In two studies, one by Butz (4) and the other by West and Brandow (38), they estimated a cost of 16 cents per 100 pounds per 100 miles. West and Brandow computed a handling charge of 15 cents at the origin and five cents at destination which added to the transportation charge to give the transfer cost.

All three authors pointed out that the variability in cost per 100 weight per 100 miles was due to length of haul, backhaul opportunity, and capacity of tanker. Butz's data were based on one-way distances of from 355 to 1444 miles. In this study the maximum distance is 3,048 miles from Boston to Portland which is outside the range of data that were reported by both Butz and West. It was logical to believe that hauls over 1500 miles would result in a decrease in the shelf-life of milk and this would offset any economies which might be offered by the longer haul. The transfer cost between Boston and Portland was $5.08 per 100 weight, whereas the feed cost per 100 weight of milk is approximately $1.00 -- a ratio of transfer cost to feed cost of about 5 to 1. Appendix Table 17 shows the transfer cost of fresh milk

Allocation Model

In order to determine the "optimum" location of production, an allocation model was designed to equate the transfer costs of a product with the feed cost difference equivalent of the transportation rate.

$$D_{ij} = P_i - (C_j + T_{ij}) \qquad \begin{matrix} i = 1, \ldots, 11 \\ j = 1, \ldots, 11 \end{matrix}$$

D_{ij} = difference between price of the product in the ith, consuming area and cost of feed to produce a unit of product in the jth producing region plus transportation cost from j to i.

P_i = Price of 100 pounds product in the ith consuming area.

C_j = Cost of feed to produce 100 pounds of product in the jth producing region;

T_{ij} = Transfer cost of 100 pounds of product from the jth producing region to the ith consuming region

The quantity of the kth product consumed in the ith region was represented by Q_i^k which was fixed for the year 1965. The largest D_{ij}^k for the ith region would give the largest net return in producing the kth product for the ith market by the jth producing region. Once the largest D_{ij}^k was selected for the ith market it was assumed that the jth region would produce the total quantity of the kth product consumed. The quantity produced in the jth region was

$$Q_j^k \geq \sum_{i=1}^{11} Q_{ij}^k \qquad \begin{matrix} k = 1, \ldots, 5 \\ j = 1, \ldots, 11 \end{matrix}$$

Another way of approaching the problem would have been to select the producing region with the minimum cost for the ith market. From the above equation P_i^k was a constant so that the D_{ij}^k will vary for the ith market only as $C_j^k + T_{ij}^k$ varies. Again

$$Q_j^k = \sum_{i=1}^{i1} Q_{ij}^k$$

The latter procedure is consistent with McPherson's effort to equate the feed cost equivalent of the transportation rate (FCETR) with the transportation rate (TR).

If the $FCETR_{ij} > TR_{ij}$ or $FCETR_{ij} - TR_{ij} > 0$ the product would be shipped from the jth producing region to the ith consuming region. The producing region with the greatest difference would ship to the ith market.

If the $FCETR_{ij} < TR_{ij}$ then the jth region would not ship to the ith consumption region. Instead the quantity consumed in the ith region would be produced at i.

The McPherson (21, p. 19) method and the minimum feed cost for a given market are equivalent. The $FCETR_{ij}$ was the feed cost difference between the ith market and jth producing area times the feed required to produce a unit of product and then compared to the transportation cost between i and j. A decision rule was applied based on the direction of the inequality. This procedure compared all alternative costs to the cost in the region, but the selection of the producing region was based on the greatest positive difference. If the FCETR was equal to or less than the TR then the location of production was in the consuming region, otherwise the production was located in the producing region with greatest positive difference.

The Iterative Procedure

The iterative process was designed to determine an "optimum" location of the five classes of animals in the eleven regions. The cost of the diets as determined in the simultaneous formulation of the least-cost models was used as a starting point. The allocation model described in the previous section was then used to determine in which regions these animals would have been fed if the FCDETR had equaled the TR. Using for each region the animal population determined in the above manner, the cost of the least-cost formulation of the diets was recalculated using the simultaneous formulation model. This procedure was continued until either a stable solution was reached or enough iterations were completed to see that the procedure would not converge to a stable solution.

Determining the "Optimum" Location of Production

An "optimum" location of production of livestock products was determined by comparing the feed cost difference equivalent of the transportation rate (FCDETR) to the transportation rate (TR). The statistic FCDETR was computed by multiplying the feed cost differences among regions times the feed conversion ratio. This was the estimated difference in cost to produce 100 pounds of livestock product among the eleven regions.

In comparing the FCDETR to the TR between two regions, the following relationships hold: (1) If FCDETR > TR, the production of the product is away from the consuming region; (2) If FCDETR < TR, the location of production is in the consuming region, and (3) If FCDETR = TR, production is in either of the two regions with neither having an advantage over the other.

The FCDEYR statistic is additionally useful in that if the FCDEYR is subtracted from the TR the difference is the amount the transportation rate has to be changed in order to give producers in the producing region the same return as producers in the consuming regions. Likewise, if transportation rates are assumed to be fixed this difference becomes the minimum difference in non-feed costs (MNFCD) which is the amount producers in a production region have to accept less on the non-feed cost factors in order to produce for a given consumption region. This difference can be viewed as the premium a producer in a consuming region could have received on the non-feed cost factors over producers located in other regions. The difference between the FCDEYR and the TR is simply the amount of money that either the transportation industry or the livestock or poultry producer in a surplus producing region must be willing to forgo per unit of product in comparison to the producer in the consuming region.

RESULTS AND ANALYSIS

The results are presented in the following order: (1) the independent determination of the quantities of the various feedstuffs that would have been consumed if each of the five classes of animals had been fed the least cost formulation of a diet that met the nutrient requirements of the given class of animals in each of the eleven regions, (2) the determination of the quantities of the various feedstuffs that would be consumed if the five classes of animals had been fed the least cost formulations of the same diets in each of the eleven regions simultaneously, (3) a comparison of the costs of the independent and simultaneous formulations of the same diets, (4) the impact of synthetic nutrients on the composition of least-cost diets and the demand for specific ingredients, and (5) the effect of reallocating the five animal populations among the eleven regions in an effort to equate the differences in feed costs with the cost of transporting products between the regions.

Results of the Independent Formulation

The utilization that each of the five classes of animals would have made of the 1965 supply of feedstuffs if they had been fed the least-cost formulation of the diets based on published prices of feedstuffs, and without regard to the nutrient requirements of other classes of animals, is shown in Table 12. For some ingredients, the indicated total consumption of the five classes of animals was equal to or greater than

Table 12.--Estimated Utilization of the 1965 Feedstuff Supply by Five Classes of Livestock, Indep[illegible]
Formulation (Billion Pounds)

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	[illegible]
Soybean Meal	20.62400	3.34253	2.35122	6.51770		2.7774	[illegible]
Cottonseed Meal	5.06600	.62584		.50793		1.20442	[illegible]
Linseed Meal	.56800						
Peanut Meal	.21600						
Coconut Meal	.21800						
Meat Meal	5.17980	.36516	.03446	.01766			.41728
Tankage	.68400			.51634			.51654
Blood Meal	.20000	.20000	.20000	.18364		.20000	.78364
Poultry-by-Product Meal	.30000						
Feather Meal	.20000	.14181	.12682			.20000	.46863
Animal Fat	.85000	.46178			.17960	.34154	.98292
Fish Meal	.85820	.08862	.15515	.00580			.24567
Fish Solubles	.56780	.05507	.20505	.00546			.26558
Gluten Meal	1.30520	1.50520	.79041				2.09931
Gluten Feed	1.50760				.01458	1.50760	1.52218
Hominy Feed	1.48000			.22420	.00142	1.11862	1.34424
Wheat Bran	6.50040	.00355					.00555
Wheat Middlings	3.25120	.00311	.14045	3.23120		3.25120	6.60596
Oat Feed	.36400		.01947	.36400			.38347
Rice Bran	.79000	.60140	.48758	.66967			1.85865
Corn F.O.B.	71.63200	5.62919	8.10680	.04472			13.78081
Barley F.O.B.	5.11000		1.03131	.00008	.19012		1.22141
Oats F.O.B.	8.39600						
Milo F.O.B.	22.28800	.91122	3.22921		5.35130	.76512	10.[illegible]
Skim Milk	.36000						
Whey	.56000						
Cane Molasses	5.95792	.73692	.84247	2.64699	3.93792	3.93792	12.10020

Table 12.--"Continued"

Foodstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
Alfalfa Meal	3.35000	.27876	52335	43900			1.24111
Beet Pulp	2.40000					.82505	82505
Brewers Grains	71000		.61000	61000			1.22000
Distillers Grains	.37000						
Brewers Yeast	10000						
Wheat F.O.B	9.00000	1.40912	.88978			.99964	3.29854
Beet Molasses	1.31468						
Citrus Pulp	.01600						
601 Corn Farm	.01600						
601 Oats Farm	.03200			.02035			[illegible]
602 Farm Corn	5.01600			.21297		4.75426	[illegible]
602 Farm Barley	69600			.69600	19012	69600	[illegible]
602 Farm Oats	1.55400						
602 Farm Milo	.01800			.01800	01800	.01800	.05400
603 Farm Corn	39.93600			10.17834	2.71929	3.02341	16.92104
603 Farm Barley	.17000			.17000	.17000	.17000	.51000
603 Farm Oats	2.73000			1.10424			1.10424
603 Farm Milo	.04600			04600	04600	.04600	.13800
604 Farm Corn	44.35000			7.54256	3.20699		10.74955
604 Farm Barley	21000						
604 Farm Oats	3.58800						
604 Farm Milo	5.88200			5.88200	5.88200	.75102	12.51502
605 Farm Corn	18.86600			3.52855	2.15169	2.71668	8.39692
605 Farm Barley	1.39800			.03305			.03305
605 Farm Oats	10.12200			2.09866		8.37593	10.47459
605 Farm Milo	.38400			.38400	.38400	.38400	1.15200
606 Farm Corn	12800						
606 Farm Barley	1.11400				.63599	82105	1.45704
606 Farm Oats	.60000			12661			.12661
607 Farm Corn	03800						
607 Farm Barley	.36600						

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
607 Farm Oats	.03000						
607 Farm Milo	.14600			.14326	.14600	.14600	.43526
608 Farm Corn	.39000						
608 Farm Barley	.34400						
608 Farm Oats	.21400						
608 Farm Milo	.49900			.27355	.49800	.49800	1.26955
609 Farm Corn	.7400						
609 Farm Barley	.26600			.18211			
609 Farm Oats	.58800						
609 Farm Milo	1.99200			.57915	1.99200	1.11350	3.68465
610 Farm Corn	5.2800			.99649	.06509	1.07988	2.14146
610 Farm Barley	.3000			.03000		.03000	.06000
610 Farm Oats	.2000						
610 Farm Milo	.07400			.07400	.07400	.07400	.22200
611 Farm Corn	6.19200			1.05004	.23023	.89267	2.17294
611 Farm Barley	.11600			.11600	.11600	.11600	.34800
611 Farm Oats	.34200			.34200			.34200
611 Farm Milo	.08800			.0800	.08800	.08800	.26400
602 Farm Wheat	.44000			.03234			.47234
603 Farm Wheat	.56400						
604 Farm Wheat	.59200						
605 Farm Wheat	.38600						
606 Farm Wheat	.62000			.33058	.62000	.62000	1.57058
607 Farm Wheat	.00400				.00400	.00400	.00800
609 Farm Wheat	.13600						
610 Farm Wheat	.09400			.09400	.09400	.09400	.28200
611 Farm Wheat	.10400			.10400			.10400
601 Alfalfa Hay	.88200						
602 Alfalfa Hay	10.53000						
603 Alfalfa Hay	20.48800					1.59254	5.59254
604 Alfalfa Hay	32.14600				5.86959	.65030	6.51989
605 Alfalfa Hay	37.28000					1.81741	1.81741
606 Alfalfa Hay	15.41600				.52325	.52937	1.05262

Table 12 --"Continued"

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
607 Alfalfa Hay	12.87200				1.34755	.60846	1.95601
608 Alfalfa Hay	13.08800				1.23356	.36722	1.60078
609 Alfalfa Hay	3.45800					.51288	.51288
610 Alfalfa Hay	1.09400						
611 Alfalfa Hay	.14800						
601 Clover-Grass Hay	2.42800				.00031	.23518	.23549
602 Clover-Grass Hay	10.17200						
603 Clover-Grass Hay	8.9000						
604 Clover-Grass Hay	6.75200						
605 Clover-Grass Hay	4.2600						
606 Clover-Grass Hay	2.84000						
607 Clover-Grass Hay	1.36600						
608 Clover-Grass Hay	1.36600						
610 Clover-Grass Hay	1.43200						
611 Clover-Grass Hay	.46000				.12838	.24095	.36933
601 Grass Hay	.75600						
602 Grass Hay	2.19200				.02415	1.77463	1.79878
603 Grass Hay	1.23400				1.23400	1.23400	2.46800
604 Grass Hay	6.70400						
605 Grass Hay	7.48200				1.47782		1.47782
606 Grass Hay	1.10200				.13368		.13368
607 Grass Hay	.79400				.79400	.38933	1.18333
608 Grass Hay	2.07600						
609 Grass Hay	5.07600				1.28583		1.28583
610 Grass Hay	4.63200				.17462	.75987	.93449
611 Grass Hay	2.66200						
601 Corn Silage	3.77800				.00023		.00023
602 Corn Silage	28.91200						
603 Corn Silage	26.01400						
604 Corn Silage	27.51400						
605 Corn Silage	58.22600						
606 Corn Silage	4.57200						
607 Corn Silage	2.40800						
608 Corn Silage	7.93800						

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
609 Corn Silage	1.00200						
610 Corn Silage	3.33800						
611 Corn Silage	4.44400						
602 Sorghum Silage	14.54200						
604 Sorghum Silage	14.54200						
605 Sorghum Silage	1.22800						
607 Sorghum Silage	57600						
608 Sorghum Silage	1.57200						
609 Sorghum Silage	3.34800						
610 Sorghum Silage	1.58800						
611 Sorghum Silage	70200						

the supply available in 1965. The competition for these ingredients among the diets affected both the cost of the diets and the quantities of the feedstuff appearing in the least-cost formulation of specific diets. Specifically, these ingredients are.

Mobile Feedstuffs

Blood Meal
Feather Meal
Gluten Meal
Gluten Feed
Wheat Middlings
Oat Feed
Rice Bran
Cane Molasses
Brewers Grains

Immobile Feedstuffs

- Philadelphia Region
  - Barley
  - Milo
  - Wheat
- Chicago Region
  - Barley
  - Milo
- Kansas City Region
  - Milo
- Minneapolis Region
  - Barley
  - Wheat
- Portland Region
  - Milo
- Los Angeles Region
  - Corn
  - Wheat
- Denver Region
  - Milo
- Ft. Worth Region
  - Milo
- Memphis Region
  - Barley
  - Milo
  - Wheat
- Atlanta Region
  - Barley
  - Milo
  - Wheat

The feedstuffs in which the indicated consumption exceeded the supply were generally by-product feeds (mobile feedstuffs), and farm grains (immobile feedstuffs) which were of minor importance in a given livestock producing region. The 'mobile feedstuffs" falling into this category were the by-products of industries which operate on a seasonal basis. Many animal feeders were not acquainted with these particular feedstuffs and their use. For the farm grains in this category, there was an apparent imperfection in the market structure. The producers lack of knowledge of the feedstuff, seasonal availability, and small volumes available to the producer resulted in an undervaluing of some ingredients in relation to their nutritive value. Table 13 shows the cost per 100 pounds of the least-cost diets through independent formulation Appendix Tables 28, 34, 40, 46, and 52 show the feedstuffs required to meet nutrient specifications by regions for the independent formulation.

Results of the Simultaneous Formulation

The quantity of each ingredient appearing in the simultaneous formulation and the class of livestock consuming the ingredient are shown in Table 14. The cost per 100 pounds of diet is shown in Table 15 Appendix Tables 29, 35, 41, 47, and 53 show the feedstuffs and quantity required to meet nutrient specifications by regions for the simultaneous formulation.

Comparison of the Independent and Simultaneous Formulations

The simultaneous formulation of the five diets in the eleven regions differed from the independent formulation in two respects First, the simultaneous formulation called for the use of more of the traditional livestock feeds such as soybean oil meal and corn than the independent formulation. In this formulation the traditional feedstuffs were substituted for those feedstuffs listed in Table 12. Secondly, the costs of the diets in the simultaneous formulation were higher because higher priced ingredients were substituted for lower priced feedstuffs as the supply became exhausted. Feedstuffs which had significant increases in usage between the two formulations are shown in Table 16.

[illegible] Pounds, by Class of Livestock, [illegible]

Region	Broiler	Layer	Hog	Beef	Dairy
Boston	3.354	2.807	2.730	2.195	2.546
Philadelphia	3.026	2.319	2.399	1.803	2.399
Chicago	3.005	2.433	2.150	1.620	2.018
Kansas City	2.791	2.361	1.958	1.559	2.034
Minneapolis	2.891	2.157	1.954	1.458	1.995
Portland	3.440	2.861	2.356	1.775	2.276
Los Angeles	3.363	2.840	2.456	1.861	2.409
Denver	2.936	2.612	2.156	1.828	2.102
Ft. Worth	3.113	2.629	2.096	1.638	2.018
Memphis	3.058	2.529	2.335	1.718	2.245
Atlanta	3.483	2.685	2.398	1.885	2.362

Table 14 --Estimated Utilization of the 1965 Feed Supply by Five Classes of Livestock, Simultaneous Formulation, (Billion Pounds)

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
Soybean Meal	20.62400	3.85952	3.10335	6.23468		3.56169	16.75944
Cottonseed Meal	5.06600	.66176		.50246		1.26529	2.42951
Linseed Meal	.56800						
Peanut Meal	.21600		.08164				.08164
Coconut Meal	.21800						
Meat Meal	3.17980	.29430	.04866	.00868			[illegible]
Tankage	.68400			.58304			.583[illegible]
Blood Meal	.20000					.20000	.20000
Poultry-by-Product Meal	.30000	.00285		.00127			.00352
Feather Meal	.20000	.11571	.06952			.01477	.20000
Animal Fat	.85000	.46179				.20404	.66583
Fish Meal	.85820	.22912	.16276				.3918[illegible]
Fish Solubles	.36780	.22387	.14393				.36[illegible]
Corn Gluten Meal	1.30520	1.10760	.14714			.05045	1.30[illegible]
Corn Gluten Feed	1.50760					1.50760	1.50[illegible]
Hominy Feed	1.48000			.02242	.00142	1.11852	[illegible]
Wheat Bran	6.30040		.13286				[illegible]
Wheat Middlings	3.23120			1.44586		1.78534	3.2[illegible]
Oat Feed	.36400			.36400			.36[illegible]
Rice Bran	.79000	.52377	.12413	.14209			.79[illegible]
Corn F.O.B.	71.63200	5.23722	8.81650	.04472			14.09[illegible]
Barley F.O.B.	5.11000		1.42647	.00008	.01389	.17465	1.61[illegible]
Oats F.O.B.	8.85600						
Milo F.O.B.	22.28800	2.11003	3.34965	.69554	5.96868	2.86458	14.98848
Wheat F.O.B.	9.0000	1.19683				.90331	2.78983
Skim Milk	.36000						
Whey	.36000						
Cane Molasses	3.93792		.04660	.23560	1.23200	2.43271	[illegible]
Alfalfa Meal	3.35000	.29815	.[illegible]8154	1.08137			2.28[illegible]

Table 16 --"Continued"

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
Beet Pulp	2.40000					.80156	.80156
Brewers Grains	.61000		52991	08010			61000
Distillers Grains	87000						
Brewers Yeast	.10000						
Citrus Pulp	64832						
601 Corn, Farm	01600						
602 Corn, Farm	5.01600			33059	15224	4.53317	5.01600
603 Corn, Farm	39.93600			10.37655	3.66290	5.10480	19.14425
604 Corn, Farm	44.35000			8.22959	10.42075		18.65074
605 Corn, Farm	18.86600			3.19864	2.52284	3.87005	9.59153
606 Corn, Farm	.12800			.09184	03616		.12800
607 Corn, Farm	.03800						
608 Corn, Farm	39000						
609 Corn, Farm	74000				.74000		.74000
610 Corn, Farm	5.28000			1.06147	24533	1.23551	2.54251
611 Corn, Farm	6.19200			1.31760	50554	1.25044	3.07358
602 Barley, Farm	.69600			56696		12904	.69600
603 Barley, Farm	.1700			.17000			.17000
604 Barley, Farm	.21000			.21000			.21000
605 Barley, Farm	1.39300			.71758			.71758
606 Barley, Farm	1.11400			.08746	1.02654		1.11420
607 Barley, Farm	.36600			.04546			.04546
608 Barley, Farm	.84400			.06791			.06791
609 Barley, Farm	.26600			26600			.26600
610 Barley, Farm	03000			.03000			.03000
611 Barley, Farm	.11600			.11600			.11600
601 Oats, Farm	03200			02035			02035
602 Oats, Farm	1.55400						
603 Oats, Farm	2.73000			2.73000			2.73000
604 Oats, Farm	3.58800			2.43716			2.43716
605 Oats, Farm	10.12200			2.21245		7.85795	10.07040

Table 14.--"Continued"

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
606 Oats, Farm	.60000			.18690	.41310		.60000
607 Oats, Farm	.03000			.03000			03000
608 Oats, Farm	.21400						
609 Oats, Farm	.58800			.17076			.17076
610 Oats, Farm	.20000			.07400			.07400
611 Oats, Farm	34200			.34200			34200
601 Milo, Farm							
602 Milo, Farm	.01800			08100			.08100
603 Milo, Farm	.04600			.04600			.0460
604 Milo, Farm	5 88200			5 15153		.73047	5 8820
605 Milo, Farm	.38400			.38400			384
607 Milo, Farm	.14600			.10577	.03623		.1460
608 Milo, Farm	.49900					.49900	39900
609 Milo, Farm	1.99200				1.47371	.51829	1.99200
610 Milo, Farm	07400						
611 Milo, Farm	.08800			08800			08800
601 Wheat, Farm							
602 Wheat, Farm	.44000					.44000	.44000
603 Wheat, Farm	.56400						
604 Wheat, Farm	.59200						
605 Wheat, Farm	.38600						
606 Wheat, Farm	.62000			00118		.61882	.62000
607 Wheat, Farm	.00400					.00400	.00400
608 Wheat, Farm	.12800						
609 Wheat, Farm	.19600					.19600	.19600
610 Wheat, Farm	.09400			.09400			.09400
611 Wheat, Farm	.10400			.10400			.10400
601 Alfalfa Hay	.88200						
602 Alfalfa Hay	10.53000						
603 Alfalfa Hay	20.48800					2.71931	2.7193
604 Alfalfa Hay	32.14600				5.81813	.86588	7.10401
605 Alfalfa Hay	47.3800					2.01320	2.01320
606 Alfalfa Hay	15.41600				.43892	.69828	1.13720

Table 14.--"Continued"

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	[illegible]
607 Alfalfa Hay	12.87200				1.54398	.94592	2.49390
608 Alfalfa Hay	13.02800				1.23356	.36722	1.60078
609 Alfalfa Hay	3.45600						
610 Alfalfa Hay	1.09400						
611 Alfalfa Hay	.14800						
601 Clover-Grass Hay	2.42800				.00031	.23518	.23549
602 Clover-Grass Hay	10.17200						
603 Clover-Grass Hay	5.90000						
604 Clover-Grass Hay	6.75200						
605 Clover-Grass Hay	4.26000						
606 Clover-Grass Hay	2.84000						
607 Clover-Grass Hay	1.36600						
608 Clover-Grass Hay	1.36600						
610 Clover-Grass Hay	1.43200						
611 Clover-Grass Hay	.40000				.14945		1454
601 Grass Hay	.75600						
602 Grass Hay	2.19200				.06564	1.85869	1.92433
603 Grass Hay	1.23400				1.18440	.04960	1.23400
604 Grass Hay	6.70400						
605 Grass Hay	7.48200				1.48153		1.48153
606 Grass Hay	1.10200						
607 Grass Hay	.79400				.58635	.20765	.79400
608 Grass Hay	2.07600						
609 Grass Hay	5.07600				1.28352	.56673	1.85020
610 Grass Hay	4.63200				.17629	.76284	.93913
611 Grass Hay	2.65200					.25823	.25823
601 Corn Silage	3.77800			.00023			.00023
602 Corn Silage	28.91200						
603 Corn Silage	26.01400						
604 Corn Silage	27.51400						
605 Corn Silage	58.22600						
606 Corn Silage	4.57200						
607 Corn Silage	2.40800						

Table 14 --"Continued"

Feedstuff	Supply	Broiler	Layer	Hog	Beef	Dairy	Total
608 Corn Silage	7.53800						
609 Corn Silage	1.00200						
610 Corn Silage	3.33800						
611 Corn Silage	4.44400						
602 Sorghum Silage	.0400						
603 Sorghum Silage	14.54200						
604 Sorghum Silage	14.54200						
605 Sorghum Silage	1.22800						
607 Sorghum Silage	.57600						
608 Sorghum Silage	1.57200						
609 Sorghum Silage	3.34800						
610 Sorghum Silage	1.48800						
611 Sorghum Silage	.70200			.00689			.00689

[illegible] Diets, Dollars Per 100 Pounds, by Class of Livestock, Simultaneous Formulation, 1965

Region	Broiler	Layer	Hog	Beef	Dairy
Boston	3.383	2.914	2.733	2.203	2.546
Philadelphia	3.093	2.520	2.413	1.976	2.415
Chicago	3.026	2.474	2.194	1.698	2.091
Kansas City	2.793	2.374	2.044	1.724	2.047
Minneapolis	2.977	2.284	1.972	1.580	2.002
Portland	3.450	2.893	2.516	1.817	2.523
Los Angeles	3.394	2.866	2.527	1.973	2.465
Denver	2.952	2.440	2.296	1.845	2.102
Ft. Worth	3.114	2.664	2.379	1.762	2.227
Memphis	3.090	2.568	2.377	1.807	2.256
Atlanta	3.524	2.748	2.472	2.072	2.467

Table 16.--Significant Increases in the Use of Feedstuffs Between the Independent and Simultaneous Formulations.

Feedstuff	Quantity (Billion Pounds)
Soybean Meal	1.6
Milo F.O.B.	4.8
Alfalfa Meal	1.1
Corn Farm--Chicago	2.7
Corn Farm--Kansas City	7.7
Corn Farm--Minneapolis	1.2
Oats Farm--Chicago	1.6

A comparison of differences in the cost of the diets between the independent and simultaneous formulations is shown in Table 17. The cost of every diet in all regions in the simultaneous formulation was higher than its cost in the independent formulation.

Table 17.--Diet Cost Differences, Cents Per 100 Pounds, Between the Independent and Simultaneous Formulation

Region	Broiler	Layer	Hog	Beef	Dairy
Boston	2.9	0.7	0.3	0.8	0.1
Philadelphia	6.7	20.1	1.4	17.3	1.6
Chicago	2.1	4.1	4.6	7.8	7.3
Kansas City	0.2	1.3	4.6	15.5	0.7
Minneapolis	8.6	12.7	1.8	12.2	0.7
Portland	1.0	3.2	16.0	4.2	24.7
Los Angeles	3.1	2.6	7.1	1.2	5.6
Denver	1.6	2.8	14.0	1.7	0.1
Ft. Worth	0.1	3.5	28.3	12.4	20.8
Memphis	3.2	3.9	4.2	8.9	1.1
Atlanta	4.1	6.3	7.4	18.7	10.5

The simultaneous formulation indicated a 7 percent higher cost for the layer diet in the Philadelphia region than the independent formulation and a 6 percent higher cost in the Minneapolis region. The costs of hog diets in the simultaneous formulation were 7 percent higher in the Portland region, 6 percent higher in the Denver region, and 13 percent higher in the Ft. Worth region. Changes in the cost of the diets between the formulations were the greatest for beef animals, where the cost of the simultaneous formulation was 5 to 10 percent higher in seven [illegible] eleven regions. [illegible] simultaneously formulating dairy diets was 10, 7, and 5 percent higher respectively in the Portland, Ft. Worth, and Atlanta regions

In the simultaneous formulation the costs of the five diets in the Atlanta region were among the four highest in the nation and the cost of broiler diet in this region was the highest (Table 18). Likewise, the difference between the costs of the diets in the two formulations of the broiler diet was the third largest difference in the nation.

The indigenous or immobile farm supplies of corn, barley, milo, and wheat were exhausted and one-third of the oats supply was utilized in the Ft. Worth region. The exhaustion of indigenous feed supply in the simultaneous formulation resulted in an increase in cost of the hog diet of 25 cents, the fed beef diet of 12 cents, and the dairy diet of 21 cents. On the other hand, the broiler and layer diet costs did not increase significantly, primarily because the ingredients used in these diets were available only in the mobile feed supply.

The increase in the costs of the poultry diets between the two formulations was the largest in the Philadelphia region. This was largely due to the exhaustion of the mobile supply of certain feedstuffs (compare Appendix Tables 28 and 29 and Appendix Tables 34 and 35)

Table 18.--Comparison of Simultaneous Formulation Diet Costs, Differences, and Ranks in the Atlanta Region

Diet	Cost Per 100 Pounds	Rank among Diet Costs in 11 Regions	Change in Cost from independent Formulation-cents/100 pounds	Rank among Increase in 11 Regions
Broiler	3.52	1	+4	2
Layer	2.75	4	+6	3
Hog	2.47	4	+7	3
Fed Beef	2.07	2	+13	1
Dairy	2.47	3	+11	3

The Philadelphia region [illegible] little of the indigenous [illegible] in the independent formulation and consequently there [illegible] very little [illegible] simultaneous formulation. The [illegible] hog and dairy diets in the region increased only [illegible] respectively between the two formulations, whereas the cost of the beef diet increased 28 cents. The relatively large increase in the cost of the beef diet indicates that this cost was highly sensitive to changes in the availability of farm corn, farm milo, farm barley, and farm wheat (the supply of which was exhausted) than the cost of the hog and dairy diets.

In seven of the eleven regions the increases in the costs of the beef diet between the independent and simultaneous solution were substantial. In the Portland region, however, the increase in the cost of the beef diet was small--much smaller than the increase in the hog and dairy diets. This was largely due to the fact that the nutrient composition of barley more nearly coincides with the nutrients required in the beef diet than the nutrient composition of other ingredients. Since there was a relatively abundant supply of barley in this region, this ingredient, plus a small amount of protein and mineral supplementation, provides an economical means of formulating this diet. In other regions, the indigenous feedstuffs fit the specification of the hog and dairy diets better than the beef diet.

In summary, an increase in diet costs occurred between the independent and simultaneous formulations. Composition of the diets also differed between the two formulations as the supplies of both "immobile feedstuffs" and the lower priced mobile by-product feedstuffs were exhausted. The allocation of individual feedstuffs to specific diets within regions does not follow traditional formulations of diets.

Synthet[illegible]

As t[illegible] synthet[illegible] role in the economics of [illegible] feeding [illegible] of the high protein feedstuffs was 33[illegible] pounds [illegible] simultaneous least-cost formulation of the fiv[illegible] utilization of 22 7 billion pounds of high protein feedst[illegible] pounds of urea. The soybean oil meal equivalent of this quantity of urea is 7.8 billion pounds. Had the urea not been available, the potential use of high protein feedstuffs would have been 30 5 billion pounds or 90 percent of the total protein supply. Likewise, the quantity of DL Methionine used was equal to the methionine supplied by 606 million pounds of 60 percent protein, menhaden fish meal.

The total utilization of synthetic nutrients estimated by the two formulations is shown in Table 19 and by regions in Appendix Tables 58 and 59. If the urea and DL Methionine had not been available, it is likely that the entire high protein feed supply would have been utilized.

Properties of Feedstuff Supply Utilized

The difference in the "optimum" utilization of the feedstuff supply as determined in this study and the actual 1965 supply of feedstuffs was caused by the fact that animals other than the 5 classes considered in this study also utilized these feedstuffs. Specifically, the amount of feedstuffs consumed by (1) turkeys (2) sheep (3) dairy cows for maintenance (4) beef cattle weighing less than 600-700 pounds and (5) pets was not considered. These animals were not included in the model because of (1) limitations on the size of problem that could be handled by MPS-360 system (13) and the IBM 360-50 computer and (2) insufficient technical data.

Table 18.--Synthetic Nutrients: Comparison of the Quantity Required for the Independent and the Simultaneous Formulations by Diet, 1965 (Pounds)

	Independent Formulation	Simultaneous Formulation	Difference
BROILER DIET			
DL Methionine	2,431,000	1,424,000	1,007,000
Vitamin A	238,250	35,890	202,360
Riboflavin	521,510	600,130	-78,620
Pantothenic Acid	1,260	6,590	- 5,330
Choline	6,680	7,800	- 1,120
Vitamin B-12	259,660	449,820	-190,160
LAYER DIET			
DL Methionine	10,480,000	10,000,000	480,000
Vitamin A	9,640	2,790	6,850
Riboflavin	1,242,420	1,118,250	124,170
Choline	5,210	61,500	-56,290
Vitamin B-12	1,366,460	1,371,930	- 5,470
HOG DIET			
DL Methionine	120,000	10,000	110,000
Vitamin A	690	1,160	- 470
Riboflavin	270,330	301,330	-31,000
Pantothenic Acid	4,470	53,500	-49,030
Vitamin B-12	4,260,060	4,285,640	-25,580
BEEF DIET			
Urea	293,360,000	287,080,000	6,280,000
Vitamin A	853,340	853,940	
DAIRY DIET			
Urea	1,011,590,000	1,011,590,000	
Vitamin A	721,180	724,390	-3,210
TOTAL			
DL Methionine	13,031,000	11,434,000	1,597,000
Urea	1,304,950,000	1,298,670,000	6,280,000
Riboflavin	2,034,320	2,019,770	14,650
Pantothenic Acid	5,730	60,090	-54,360
Choline	11,890	69,300	-57,410
Vitamin B-12	5,886,180	6,107,390	-220,910
Vitamin A	1,823,700	1,618,170	205,530

[illegible] developed to determi[illegible] consumed by the several [illegible] attempt to optimally allocate the feed supply [illegible] sufficient requirements of animals, the difference between the "optimal" quantities required by the 5 classes of animals and quantities available represents a first approximation of the quantities of feedstuffs available for the animals not included in the model. The study indicates that the feedstuffs available for these animals include substantial quantities of oil seed meals, corn, milo, hays and silages - the feedstuffs which are normally fed to these classes of animals.

This method of allocating the feed supply, with all classes of livestock included, may be more efficient than the procedures currently followed by livestock producers. If this is true, there should also be an excess of feedstuffs over the amount required to feed the current livestock population.

Results of the Iterative Formulations

The results of four attempts to equate the difference in diet costs with the cost of transporting the product from surplus to deficit regions are presented in the following order: broilers, layers, hogs, fed beef, and dairy. The original intent of the study was to continue the iterative procedure until it converged to a stable solution. However, after four iterations it became evident that the allocation method used would not coverge to a solution in a reasonable number of iterations, if at all. The objective function, which was the least-cost formulation of five diets in the eleven regions, was 4,046 million dollars for the first iteration, 4,147 million dollars for the second iteration, 4,023 million dollars for the total [illegible] for the fourth iteration This suggests that had the procedure been continued, the total cost of the five diets would have been minimized at a somewhat lower level than in the first iteration. In computing the feed cost differences (FCD) and the feed cost difference equivalent of the transportation rate (FCDETR) among regions the average of the four solutions was used These average costs and their standard deviations are shown in Table 20.

The average of the four solutions was used because it was the best estimate of the optimal allocation of animals on the basis of costs of the least-cost formulation of diets The allocation model did not estimate the amount of partial specialization that could take place in a region. Diet costs increased when more feedstuffs were required than were available in the immobile supply and decreased when the indigenous feed supply was not fully used In using a single iteration to compute cost differences among regions, the true relationship would have been masked, as some regions had lower costs because the indigenous feedstuff supply had not been exhausted, while other regions had a higher cost due to consumption in excess of the indigenous feedstuff supply.

Broilers

The results of the formulation of the broiler diets for the four iterations are presented in the following order (1) the feed cost difference equivalent of the transportation rate (FCDETR) Table 21, (2) the differences between the FCDETR and the transportation rate (TR), (3) the minimum non-feed cost differences among regions, and (4) the changes in transportation rates necessary to neutralize the effects of differing feed costs among regions.

Table 20 --Average Cost [illegible]
Eleven Regions for the Fi[illegible]

	Broilers		[illegible]		[illegible]		[illegible]		Dairy	
Region	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s	$\overline{X}$	s
Boston	341	0.96	284	2.31	274	1.15	221	0.82	234	0.00
Philadelphia	311	0.82	252	0.00	248	13.00	199	2.87	246	4.12
Chicago	297	0.00	245	0.82	214	0.58	174	2.50	209	0.00
Kansas City	279	0.00	232	0.58	198	3.32	172	0.00	204	0.00
Minneapolis	290	0.96	231	2.22	197	1.26	159	1.41	194	0.50
Portland	335	4.76	284	4.20	258	0.96	184	1.73	225	5.12
Los Angeles	332	4.51	286	0.58	259	11.32	200	1.73	244	4.50
Denver	299	2.00	248	4.04	232	6.19	184	5.56	216	3.50
Ft. Worth	316	1.83	266	1.26	224	11.20	182	10.23	208	1.26
Memphis	314	4.03	256	0.50	231	13.24	184	4.97	218	4.69
Atlanta	326	4.08	274	0.50	232	14.93	204	6.65	243	3.46

[a] See Appendix Tables 18 through 22 for the costs at each iteration. Composition of the diets associated with these costs is shown in Appendix Tables 30-33 for broilers; Appendix Tables 36-39 for layers, Appendix Tables 42-45 for hogs, Appendix Tables 48-51 for fed beef, and Appendix Tables 54-57 for dairy.

Table 21.--Broilers: Feed Cost Difference Equivalent to Transportation Rate (FCDETR) by Regions, Cents Per 100 Pounds[a]

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-84	-123	-174	-143	-6	-25	-118	-70	-76	-42
Philadelphia	84	--	-39	-90	-59	78	59	-34	14	8	42
Chicago	123[b]	39	-	50	20	118	98	6	53	48	81
Kansas City	174[b]	90	50	--	331	168[b]	148[b]	56	104[b]	98[b]	132[b]
Minneapolis	143[b]	59	20	-31	--	137[b]	118	25	73	67	101
Portland	6	-78	-118	-168	-137	--	-20	-112	-64	-70	-36
Los Angeles	25	59	-98	-148	-118	20	--	-92	-45	-50	-17
Denver	118	34	-6	-56	-25	112[b]	92	—	48	42	76
Ft. Worth	70	-14	-53	-104	-73	64	45	-48	—	6	28
Memphis	76	-8	-48	-98	-67	70	50	-42	6	—	34
Atlanta	42	-42	-81	-132	-101	36	17	-76	-28	34	—

[a] Feed cost difference (Appendix Table 23) times 2.8 feed conversion ratio.

[b] FCDETR greater than transportation rate (Appendix Table 12).

When the $PCDETR_{ij} - TR_{ij} > 0$ bet[illegible] j was shipped n from region i. The [illegible] differences are shown in Table 22. The direction of shipment [illegible]:

Production	Consumption
Chicago, Kansas City, Minneapolis	Boston
Philadelphia	Philadelphia
Chicago	Chicago
Kansas City	Kansas City
Minneapolis	Minneapolis
Kansas City, Minneapolis, Denver	Portland
Kansas City	Los Angeles
Kansas City	Ft. Worth
Denver	Denver
Kansas City	Memphis
Kansas City	Atlanta

An estimate of the minimum differences in non-feed costs between regions was made by subtracting the PCDETR from the TR (Table 22). This is the minimum difference that could have existed if shipment had been made between a producing and a consuming region assuming constant transportation rates.

The values in the producing region row are the minimum amounts that will induce shipment for the ith producing region to the jth consuming region. For example, if the Atlanta region was to have produced broilers to be consumed in Chicago, the non-feed costs would have to be 1.93 cents per pound less than the non-feed costs in Chicago to offset the transportation rate and the difference in diet costs. A negative value means that the non-feed cost in the producing region could have been higher than the consuming region and

Table 22.--Broilers: Differences[a] Between the Transportation Rate (TR) and the Feed Cost Difference Equivalent of the Transportation Rate (FCDETR) by Regions (Cents Per 100 Pounds)

Producing Region	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	175	263	408	372	258	277	416	249	262	207
Philadelphia	7	---	187	312	276	174	193	320	147	152	97
Chicago	-31	46	---	124	89	44	64	132	76	33	20
Kansas City	-25	47	24	---	47	-38	-18	38	-21	-22	-26
Minneapolis	-2	76	49	109	---	7	19	95	60	35	21
Portland	246	330	269	298	267	---	109	217	215	221	268
Los Angeles	227	311	249	278	255	69	---	197	175	201	249
Denver	71	145	144	150	145	-7	13	---	66	72	75
Ft. Worth	109	175	182	187	132	98	85	162	---	90	79
Memphis	72	128	163	207	225	192	87	229	74	---	26
Atlanta	79	133	153	256	242	196	215	244	150	94	---

[a] Transportation rate (Appendix Table 12) minus feed cost difference equivalent of transportation rate (Table 21).

shipments would still have occurred between the producing and consuming region. In essence, either the non-feed factors would have to be more efficient in the producing region than the consuming region, or these factors would have had to be paid less to offset these transportation and feed cost differences. Table 23 shows non-feed costs at three percentages of six assumed total costs of producing a pound of dressed broiler. The differences between the FCDETR and the TR (Table 22) compared to the non feed costs at several different total costs of production (Table 23) indicate that in some regions certain factors of production must be paid significantly less than the same factors in other producing regions. For example, the amounts by which the non-feed cost factors in the Atlanta region would have to be more efficient than the same factors in the Chicago region, with the total cost of a broiler carcass of 20 cents per pound, were 32, 24, and 19 percent with the non feed costs at 30, 40, and 50 percent of total cost, respectively.

Table 23.—Broilers: Non Feed Costs at Varying Percentages of Several Total Production Costs

Total Cost (cents per pound)	Non-Feed Cost: 30 Percent of Total Cost (cents per pound)	40 Percent of Total Cost (cents per pound)	50 Percent of Total Cost (cents per pound)
16	4.8	6.4	8.0
18	5.4	7.2	9.0
20	6.0	8.0	10.0
22	6.6	8.8	11.0
24	7.2	9.6	12.0
26	7.8	10.4	13.0

Assuming non-feed costs are equal between producing and consuming regions, then the difference in the FCDETR and TR becomes the amount by which transportation rates must be changed for shipments to begin between producing and consuming regions.

If producers in a region wish only to produce the amount of broilers consumed in the region then an estimate of the premium that the non-feed costs factors of production could have received in 1965 is shown in the consuming region column of Table 22. For example, a producer at Kansas City would have received 1.09 cents per pound premium before another region could have shipped broilers into the Kansas City region. Likewise, an Atlanta producer would receive .26 cents per pound of broiler less than producers in Kansas City who shipped broilers into the Atlanta region for consumption. In essence, two situations have been developed: (1) producers in a producing region who wished to ship broilers to other regions for consumption, and (2) producers within the consumption region who wished to produce broilers for consumption within the region.

In summary, the two dominant production regions for broilers, Memphis and Atlanta, with 63.2 percent of the U.S. broiler production, appeared to be at a disadvantage based on the results of this study. In 1965 the Chicago, Kansas City, and Minneapolis regions, which produced only a small percentage of the U.S. broiler production, had an advantage based on feed cost and transportation cost differences over most other broiler producing regions.

Eggs

After the first iteration and allocation, the location of the production of eggs remained fixed for subsequent iterations with production located in the region where they had to be consumed. This market orientation of production was consistent with logic in that eggs are perishable, fragile, and require bulky shipping containers. Another advantage of market orientation of egg production which was not considered in this study was the market for cull hens.

The FCDETR's (Table 24) were compared with the TR's based on shipments in refrigerated rail cars. Refrigerated rail car rates were not compared with truck rates because of the difficulties encountered in obtaining reliable data on truck rates between the eleven market areas.

The recent expansion of the egg industry in the Memphis and Atlanta regions (Appendix Table 3) is difficult to explain by comparing differences in the FCDETR's and TR's between regions (Table 25). In order for these regions to ship eggs outside of the region, it would have been necessary for producers to accept from 1.7 to 4.4 cents less per dozen in the Memphis region than producers in the consuming region, while Atlanta producers would have been required to accept from 3.2 to 5.6 cents less per dozen. In most regions this analysis showed that producers should have received a premium for eggs that were produced for consumption within the region.

Hogs

The production pattern of pork in 1965 approximated an equilibrium solution if feed cost differences were used as the judgment criteria. The cost-quantity relationships between regions in the four solutions showed a different sequence than the four other classes of livestock. When a deficit region showed an increase in production from one iteration to the next, there was a corresponding rise in cost

Table 24.—Layers: Feed Cost Difference Equivalent [illegible] Transportation Rate (FCDETR) Cents by 100 Pounds by Regions[a]

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	-82	-99	-133	-130	0	5	-92	-46	-71	-26
Philadelphia	82	—	-18	-51	-54	82	87	-10	36	10	56
Chicago	59	18	--	-33	-36	59	105	8	54	28	74
Kansas City	133	51	33	—	3	133	138	41	87	61	107
Minneapolis	130	54	36	3	--	135	140	43	89	64	110
Portland	0	-82	-99	-133	-135	--	5	-92	-46	-71	-26
Los Angeles	5	-87	105	-138	-140	-5	--	-97	51	-76	31
Denver	92	10	-8	-41	-43	92	97	--	46	20	66
Ft Worth	46	-36	-54	-87	-89	46	51	46	—	-26	20
Memphis	71	-10	-28	-61	-64	71	76	-20	26	--	46
Atlanta	26	-56	-74	107	-110	26	31	-66	-20	-46	—

[a] Feed cost difference (Appendix Table 24) times 2 55 feed conversion ratio.

Table [illegible] Difference[a] Between the Transportation Rate (TR) and the Feed Cost Difference Equivalent of the Transportation Rate (FCDETR), by Regions (Cents Per 100 Pounds)

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	215	325	385	382	252	247	244	298	323	278
Philadelphia	51	---	234	301	306	170	165	262	716	242	154
Chicago	138	198	---	184	180	78	72	237	180	136	129
Kansas City	164	222	118	---	161	19	14	111	65	97	117
Minneapolis	150	214	108	155	---	17	12	115	63	152	145
Portland	415	497	503	527	529	---	164	458	440	465	430
Los Angeles	420	502	509	532	534	174	---	463	445	470	435
Denver	285	346	253	223	263	60	55	---	167	225	238
Ft. Worth	316	357	288	251	326	131	101	259	---	188	220
Memphis	271	262	192	213	241	106	176	172	126	---	102
Atlanta	229	266	277	331	342	206	701	298	240	194	---

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[a] Transportation rate (Appendix Table 16) minus feed cost difference equivalent of transportation rate (Table 34).

(Appendix Table 20). Likewi [illegible] accompanied by a decrease in prices.

In examining the FCDETR's for po [illegible] cases where the FCDETR's were greater than the TR's (Appendix Tables 14 and 15). These cases were Philadelphia, Chicago, Kansas City, and Minneapolis being greater than Boston, Kansas City greater than Memphis and Denver, and Minneapolis greater than Philadelphia. However, in comparing the FCDETR's to the TR's there were several instances in which the FCDETR's of Chicago, Kansas City, and Minneapolis regions approach the TR's to the other consuming regions. The relationship between the FCDETR's to the TR's in the regions currently producing most of the nations pork, and the possible economies of scale in the assembly and marketing of pork and pork products in these regions suggests that major changes in the cost structure of this industry would be required before it would become profitable to produce large quantities of hogs in other regions. Based on the results of this study, the three regions Chicago, Kansas City, and Minneapolis, which produce 85 percent of the nation's pork, appear likely to continue as the major pork producers. Since the TR for production to be oriented to either the market or feed production areas. Historically, the pork industry has been oriented to the feed producing region and the cost structure in 1965 indicated there was little incentive for the industry to expand production elsewhere.

Fed Beef

The difference in the TR's and FCDETR's based on the costs from the four iterations indicated that the "optimum" location of the fed beef industry would have been in market or consumption regions with two

Table 26.--Hogs: Feed Cost Difference Equivalent of the Transportation Rate[a] (FCDETR), Cents Per 100 Pounds, by Regions

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-98	-226	-287	-290	-60	-57	-158	-188	-162	158
Philadelphia	98[b]	--	-128	-188	-192	38	41	-60	-90	64	-60
Chicago	226[b]	128	---	-60	64	166	170	68	38	64	68
Kansas City	287[b]	188	60	---	-4	226	230	128[b]	98	124[b]	128
Minneapolis	290[b]	192[b]	64	4	--	230	234	132	102	128	132
Portland	60	-38	166	-226	-230	--	4	98	-128	102	-98
Los Angeles	57	-41	-170	230	-234	-4	--	-102	-132	-106	-102
Denver	158	60	-68	-128	-132	98	102	--	-30	-4	0
Ft. Worth	188	90	-38	-98	-102	128	132	30	-	26	30
Memphis	162	64	64	-124	-128	102	106	4	26	--	4
Atlanta	158	60	-68	-128	-132	98	102	0	-30	-4	--

[a] Feed cost difference (Appendix Table 25) times 3 77 feed conversion ratio

[b] FCDEIR greater than TR (Appendix Tables 14 and 15).

Table 27 --Hogs Difference[a] Between the Transportation Rate (TR) and the Feed Cost Difference Equivalent of the Transportation Rate (FCDETR) by Regions (Cents Per 100 Pounds)

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	167	389	508	493	406	407	435	445	366	333
Philadelphia	-29	---	264	378	375	297	292	317	320	231	197
Chicago	-63	8	---	160	151	110	104	105	121	47	57
Kansas City	-66	2	40	---	104	23	3	-7	10	-34	10
Minneapolis	-87	-9	23	96	---	12	17	10	64	13	39
Portland	286	373	442	475	472	---	155	280	389	386	412
Los Angeles	297	374	444	463	485	163	---	262	348	366	395
Denver	119	197	241	249	274	84	58	---	164	171	215
Ft Worth	68	140	197	207	268	133	84	104	---	80	119
Memphis	42	103	175	214	269	182	160	163	80	---	79
Atlanta	17	77	193	266	303	216	191	215	179	79	---

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[a] Transportation rate (Appendix Table 14) minus feed cost difference equivalent of transportation rate (Table 26).

exceptions, Atlanta and [illegible] deviations of the TR and FCDETR ex[illegible] to Philadelphia, and from Chicago, Kansas City, and [illegible]. Elements omitted in the study, but important in the location of feedlots, were the cost and sources of feeder steers. Feeder steers were assumed to be available in unlimited supply and at a constant price in all regions.

The closeness of the differences in the TR's and FCDETR's to zero between the Atlanta and Midwestern producing areas indicates that transportation rates and feed cost differences were almost equal. This means that there was little advantage for production firms to be located in either the production or consumption areas for the quantity of fed beef consumed in this region. Non feed cost factors have played an important role in this orientation. They may also explain why there was production of fed cattle in both areas during 1965. Potential expansion was indicated in the Philadelphia region, but the market oriented producers could have commanded at most 23 cents per 100 pounds over the Midwestern producers. Producers in other regions could have obtained a substantial premium for producing fed beef for consumption whithin the region.

Fresh Milk

The relationship between the FCDETR's and TR's explains why fluid milk production market was oriented in 1965 (Table 30). This was a logical orientation when the perishability of the commodity, the water content and feed requirements (40 pounds of feed per 100 pounds of milk) were taken into consideration. Even though the amount of dairy diet required in each region was constant between iterations of the simultaneous formulations the cost in some of the feed deficit areas varied from 2-5 percent from iteration to iteration.

[illegible] Difference[a] Between the Transportation Rate (TR) and the Feed Cost Difference Equivalent of the Transportation Rate (FCDETR) by Regions (Cents Per 100 Pounds)

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	157	351	417	451	494	434	425	413	352	245
Philadelphia	-19	---	236	298	343	395	329	317	298	227	117
Chicago	-25	36	---	106	147	236	170	233	217	71	5
Kansas City	25	92	92	---	152	201	121	73	68	42	10
Minneapolis	45	23	27	48	---	142	187	42	74	41	-5
Portland	198	275	316	297	342	---	95	182	268	284	234
Los Angeles	266	337	378	345	415	223	---	234	288	324	277
Denver	129	197	213	169	242	182	96	---	142	167	135
Ft Worth	101	162	291	148	258	253	164	126	---	98	61
Memphis	56	107	151	138	241	284	324	167	114	---	3
Atlanta	117	157	245	266	347	394	309	295	237	163	---

[a] Transportation rate (Appendix Table 14) minus feed cost difference equivalent of transportation rate (Table 29)

Table 29 [illegible] transportation [illegible]
Rate (FCDETR), [illegible]

	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-88	-188	-196	-248	[illegible]	[illegible]	-148	-156	-148	-68
Philadelphia	88[b]	--	-100	-108	-160	-60	4	-60	-68	-60	20
Chicago	188[b]	100	--	-8	-60	40	104	40	32	40	120
Kansas City	196	108	8	—	-52	48	112	48	40	48	128
Minneapolis	248[b]	160	60	52	—	100	164	100	92	100	176[b]
Portland	148	60	-40	-48	-100	--	64	-	-8	0	80
Los Angeles	84	-4	-104	-112	-164	-64	-	-74	-72	-64	16
Denver	148	60	-40	-48	-100	0	64	-	-8	0	80
Ft. Worth	156	68	-32	-40	-92	8	72	8	--	8	88
Memphis	148	60	-40	-48	-100	0	64	0	8	--	80
Atlanta	68	-20	-120	-128	-176	-80	-16	-80	-88	-80	--

[a] Feed cost difference (Appendix Table 26) times 4.0 feed conversion factor

[b] FCDETR greater than TR (Appendix Tables 14 and 15)

Table 30.--Milk Differences[a] Between Transportation Rate (TR) and Feed Cost Difference Equivalent of the Transportation Rate (FCDETR) by Regions (Cents Per 100 Pounds)

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	73	192	264	263	520	502	349	329	245	193
Philadelphia	63	---	154	216	224	481	454	304	277	193	140
Chicago	156	124	---	102	91	348	340	177	172	101	117
Kansas City	224	182	98	---	96	304	257	111	101	91	134
Minneapolis	215	182	79	88	--	276	306	146	169	145	174
Portland	496	463	360	322	302	---	167	227	347	389	449
Los Angeles	494	452	368	289	346	183	---	201	252	321	369
Denver	319	280	183	121	164	219	189	---	146	185	358
Ft. Worth	291	247	172	105	181	333	222	234	--	96	138
Memphis	215	171	109	103	165	383	299	311	190	---	142
Atlanta	183	138	145	156	214	435	369	380	359	162	---

[a] Transportation rate (Appendix Table 17) minus feed cost difference equivalent of transportation rate (Table 31)

The range of [illegible] was from [illegible] cents for 100 pounds to 24 cents (Table [illegible] [illegible] [illegible] considerably larger (up to 20 times) [illegible].

The price range [illegible] [illegible] from 4 7 dollar per 100 pounds. The [illegible] [illegible], MNFCD, ranged from 63-520 cents per 100 pounds. [illegible] [illegible] tuted from 50 100 percent of the price differen[illegible] [illegible]. This indicates that it would have been necessary for producers [illegible] extremely low payments from non-feed factors in order to be able to ship milk from one region to another.

In summary, milk has a market oriented production location with producers in each region enjoying a substantial protection or protective from competition from other regions, depending upon the interpretation, due to the bulk and perishability of milk.

The Relative Competitive Position of Producing Regions

The relative competitive position of the eleven regions was evaluated by comparing the costs of transporting the products (TR tables) with the Feed Cost Difference Equivalent of the Transportation Rate (FCDETR). These data are located in tables in the sections where each class of livestock is discussed.

Boston Region

Producers in the Boston region did not enjoy any appreciable advantage in the production of milk and eggs for consumption within the region based on the comparison of the TR's to the FCDETR's over other

Table 31.—[illegible] Equivalent of the [illegible]portation Rate (FCD1[illegible]) [illegible] by Region

	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-5	-18	-20	-24	-12	-4	-15	-19	15	-5
Philadelphia	5	-	-15	-17	-21	-9	-1	-12	-15	-11	-1
Chicago	18	15	--	-2	-6	6	14	3	0	4	14
Kansas City	20	17	2	-	-4	9	16	5	2	6	16
Minneapolis	24	21	6	4	--	13	20	9	6	10	20
Portland	12	9	-6	-9	-13	--	8	-4	-7	3	-7
Los Angeles	4	1	-14	-16	-20	-8	--	-11	-15	-11	0
Denver	15	12	-3	-5	-9	4	11	--	-3	1	11
Ft. Worth	19	15	0	-2	-6	7	15	3	--	4	14
Memphis	15	11	-4	-6	-10	3	11	-1	-4	--	10
Atlanta	5	1	-14	-16	-20	7	0	-12	-14	10	--

[a] Feed cost differences (Appendix Table 27) times .405 feed conversion ratio.

producers [illegible] had [illegible] for the broiler, [illegible] market for these products. The Boston [illegible] was not in a position to produce any of the five livestock products for consumption in other regions.

Philadelphia Region

Producers in the Philadelphia region had an advantage in producing broilers, eggs, fed beef, and milk for consumption within the region, plus an advantage over Boston producers in producing fed beef and pork for consumption within Boston region. In 1965, producers in the Philadelphia region produced only a small proportion of the fed beef and pork consumed in the region. The prospects of this region becoming a surplus producer of the five livestock products appeared remote based on the results of this study and the fact that the region contained 24.7 percent of the U.S. population in 1965.

Chicago Region

In 1965, producers in the Chicago region produced a large percentage of the region's consumption of eggs, fed beef, and milk, but produced only a very small proportion of its broiler consumption, and was a surplus producer of pork. In the Chicago region the producers of every class of livestock were in a position to obtain a premium price for products consumed locally. In producing broilers for shipment to other regions an advantage existed over the Boston producer, and with small discount on non-feed cost factors, the Chicago region producers could have competed with the Memphis and Atlanta producer for the products consumed in these regions.

Kansas City Region

The Kansas City region was a surplus producer of eggs, fed beef, pork and milk in 1965 and a deficit producer of broilers in relation to the region's consumption of these products. The Kansas City broiler producer could either have obtained lower non-feed costs, or a higher return on non-feed costs, than producers in 6 of the other 10 regions. Likewise, in pork production an advantage existed over the producers in the three other regions and an almost equal advantage existed with producers in four other regions. In the production of eggs and fed beef the Kansas City region producer had an almost equal advantage with two regions.

Minneapolis Region

The Minneapolis region was a surplus producer of fed beef, milk, pork, and eggs and a deficit producer of broilers for 1965. The producer in this region had an advantage over producers in two other regions in the production of broilers, pork, and fed beef, and a near advantage over several additional regions in the production of broilers, eggs, and pork.

Portland Region

The Portland region was deficit in the production of broilers, fed beef, and pork in 1965 and produced practically all of its consumption of milk and eggs. Producers in this region did not have a reasonable chance to ship products out of the region, and were faced with a situation in which producers in other regions had almost an equal chance of producing livestock products for consumption in the Portland region.

Los Angeles Region

Producers in the Los Angeles region produced the approximate quantity of fed beef, eggs, and milk consumed in the region during 1965 with the quantity of broilers and pork produced being less than the estimated consumption. The producers of the five livestock products in the Los Angeles region had an advantage over producers in other regions for the quantity of the products consumed within the region. However, the Los Angeles producers were not able to return to the non-feed cost factors as much as producers in other regions could in producing for markets outside the region.

Denver Region

The Denver region produced a surplus of fed beef, and was deficit in the production of broilers and pork, but produced a high percentage of the milk and eggs consumed in the region during 1965 The results from this study indicate that producers in the Denver region should have produced all of the eggs, milk, beef, and pork consumed in the region. However, the 1965 pattern of production was most likely the "optimum" in that the region had a surplus of feeder cattle, and that the most efficient method of marketing the indigenous supply of feed and the feeder cattle was to combine them into fed beef.

Ft. Worth Region

Producers in the Ft. Worth region appeared to be producing approximately the amount of the five livestock products consumed in the region with the exception of pork during 1965 The comparison of the FCDTR's and the TR's indicated that the production of broilers and pork for the

Ft. Worth region could be eith[illegible] feed producing region oriented. The other three prod[illegible]et oriented in production in this region with the producers r[illegible]ing a higher return on the non-feed cost factors.

Memphis Region

Memphis region growers produced a surplus of broilers and eggs, and produced a deficit of pork and fed beef. Producers in this region had to accept a lower return on the non feed cost factors or be more efficient in production than producers in other regions in order to produce the surplus of broilers and eggs that occurred in 1965. This lower return also applied to broilers and pork produced for consumption in the region, as producers in other regions had an advantage according to these results. The other three livestock products could have been produced in the amount equaling the quantity consumed which result in the producers receiving a premium.

Atlanta Region

Producers in the Atlanta region were producing a surplus of broilers and eggs in 1965 in relation to consumption and less than the amount fed beef and pork consumed within the region. The results indicated that this region had a competitive advantage in feed cost for the production of milk, pork, and eggs for the consumption within the region. The non-feed cost factors of production play a strong role in the location of production of fed beef for consumption in the region. Broiler producers had to either accept lower returns on non-feed cost factors or be more efficient in production than producers in other regions in order to produce the broilers consumed by the region's residents. Any livestock product, which had a total production in excess of the Atlanta region's consumption in 1965 would have had to take significantly less returns on the non-feed cost factors or be extremely more efficient than producers in other regions.

SUMMARY AND CONCLUSIONS

In this study a linear programming model was developed to allocate the 1965 supply of livestock feedstuffs to the broilers, layers, hogs, beef cattle, and dairy cattle produced in each of eleven regions of the country during that year. The allocation of production was based on the least-cost formulation of diets that met nutritional requirements established by the National Research Council. The feedstuff supply was first allocated to each class of animals independently and then to the five classes simultaneously. The cost and composition of the diet for each class of animal in every region was compared between the independent and simultaneous formulations of the diets. An effort was made to determine the "optimum" location to produce the five classes of animals on the basis of the cost of the least-cost formulation of diets by an iterative procedure, using the simultaneous formulation model. However, the procedure was not converging at a satisfactory rate towards a stable solution and, after four iterations, the procedure was terminated. An alternate procedure using the average cost of the diet for each region and class of animals was used to compute the food cost difference equivalent of the transportation rate (FCDETR) between regions. The iterative procedure was slow to converge because the allocation model did not allow for partial specialization of production within a region.

Diet costs were relatively high in regions in which the supply of nutrients was not sufficient to produce the quantity of livestock products consumed, i.e., deficit feedstuff producing areas. To the extent that locally produced feedstuffs were available, livestock producers in deficit feedstuffs producing areas appeared to have an advantage over producers in surplus feedstuffs producing regions for the market in these regions. Once the local supplies of feedstuffs were utilized the cost of the diet increased rapidly in the deficit feedstuffs producing regions.

The cost of the least cost formulation of the diets was higher when the feedstuffs were allocated among classes of animals simultaneously than when allocated independently. This was due to the competition for the aggregate supply of nutrients among the five classes of livestock. The nutrient supply is contained in feedstuffs which have differing quantities of nutrients such that the supply of the feedstuffs with the cheapest source of the limiting nutrient is exhausted first. In general, the indigeneous feedstuffs were the cheapest source of nutrients, and the costs of diets increased as alternative sources had to be found to furnish the required amounts of the limiting nutrients.

Four iterations of a procedure in which the simultaneous model was used to reallocate the feed supply among animal populations determined by a model designed to equate feed difficulties with transportation costs did not determine an "optimum" allocation of animals. However, an average of the costs from the four iterations did give an estimate of feed cost for each class of animals by region. The location of broiler production appeared to be significantly out of phase with the TR and FCDSTR method of orienting production. This suggests that in 1965 any large scale expansion of the broiler industry would have occurred outside of the two major producing regions. The expansion would have most likely occurred in the three Midwestern regions, based on these comparisons. Egg and milk production were market oriented in location and an expansion of the industry at that time would have been dependent upon size of the m within each region. Pork producers faced a general situation of bei neither market nor feed producing region oriented due to the TR and FCDETR differences being relatively small. However, the industry was feed producing region oriented and there was no strong incentive to produce pork outside the current producing regions.

The production of fed beef was generally market oriented in comparing the TR's and FCDETR's, however, the costs of the fed beef diet tended to be the more sensitive to the exhaustion of the local feed supplies than the cost of the hog or dairy diets. The extent to which fed beef production was market oriented appeared to depend upon the quantity of locally produced feedstuffs available in consumption areas.

In general, the hypothesis that livestock and livestock products were being produced in areas where the cost of shipping a unit of product from the producing region to the consuming region was less than the difference in the cost of the diet between the two regions used to produce the unit of product was found to be true. The notable exception was broilers and, to a lesser extent, fed beef. However, broilers were produced in 1965 in regions where the reverse of the hypothesis was true and, also, they were produced in feed deficit areas. Fed beef production, on the other hand, was not completely oriented to surplus feed producing regions.

The implications for transportation policy from this study were that the transportation rates on pork carcasses were at a level that did not influence the orientation of production between a surplus and deficit feedstuff production area. The transportation rate on fed beef carcasses was high enough to cause the "optimum" location of production to be partially market oriented. However, the transportation rates for beef and pork [illegible] and furth[illegible] to determine [illegible] rates on these [illegible] should [illegible] critical The bulky and the short shelf-life [illegible] d milk causes the production of these products to be oriented towards a market location because the amount of transportation rates would have to decrease to change the location of production were relatively large Restructuring of the rates on broilers within the limit of the FCDRTR-TR differences may be economically feasible to the transportation industry in order to neutralize any advantage one region has over another

From a national policy viewpoint concerning the feedstuff supply, the influence of various policies on diet costs of both regional and national levels can be estimated by the use of this model Policies such as: (1) The effect of increasing the price on a commodity or commodities, (2) changing the levels of production of various feedstuffs, (3) the effect of new feedstuffs or nutrient sources on livestock production, (4) a simultaneous price and volume change of one or several feedstuffs, (5) changing the nutrient levels of certain feedstuffs, e.g., increasing lysine content of corn, and the economic impact on the various sectors of the livestock-feed industry

The simultaneous least cost formulation model of the five diets in eleven regions could be expanded to k diets and n regions In addition, this model could be used in a comprehensive spatial equilibrium or simulation model of the livestock-feed sub sector of the national economy. This would enable the researcher to utilize realistic diet costs and thus avoid making the broad assumptions that are frequently made in spatial equilibrium models.

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Appendix Table 1. -Population[a] of United States (Thousands) by
1950, 1955, 1960, 1965

Market Center	Year			
	1950	1955	1960	1965
Boston	9,315	9,871	10,534	11,145
Philadelphia	38,951	41,791	44,463	47,590
Chicago	28,910	33,020	35,362	37,275
Kansas City	9,807	10,280	10,678	10,949
Minneapolis	7,690	8,129	8,699	9,040
Portland	5,080	5,317	5,981	6,307
Los Angeles	10,586	13,133	15,863	18,403
Denver	3,896	4,645	5,567	6,296
Ft. Worth	9,944	10,910	11,967	13,039
Memphis	13,127	13,796	14,093	15,146
Atlanta	12,395	13,825	15,925	17,672
United States	150,701	164,307	179,132	192,862

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[a] U S Department of Commerce, Statistical Abstracts of the United States, 1967, page 12.

Appendix Table 2.--Broiler Production in the United States by Regions, 1950, 1955, 1960, 1965.

Region		Production							
		1950		1955		1960		1965	
		Thousand Pounds	Per-cent	Thousand Pounds	Per-cent	Thousand Pounds	Per-cent	Thousand Pounds	Per-cent
1	Boston	196,666	10.1	301,413	9.0	351,290	5.8	337,656	4.[illegible]
2	Philadelphia	689,815	33.4	825,040	24.6	1,179,601	19.6	1,266,861	16.8
3	Chicago	131,028	7.8	229,934	6.8	259,861	4.3	160,14[illegible]	[illegible]
4	Kansas City	71,115	3.7	108,703	3.2	130,326	2.2	119,158	1.5
5	Minneapolis	24,873	1.3	51,363	1.5	93,497	1.6	96,775	1.2
6	Portland	30,303	1.6	33,083	1.6	104,561	1.7	131,393	1.6
7	Los Angeles	134,195	6.9	150,400	4.3	191,860	3.2	227,438	2.8
8	Denver	9,959	0.3	13,399	0.4	12,389	0.2	10,348	0.1
9	Ft. Worth	97,988	5.0	249,736	7.5	338,125	6.0	513,370	6.3
10	Memphis	237,434	12.2	572,850	17.2	1,678,226	27.8	2,824,447	34.9
11	Atlanta	301,148	13.3	790,332	23.6	1,663,612	27.6	2,291,363	28.3
	United States	1,944,524	100.0	3,346,315	100.0	6,017,332	100.0	8,100,946	100.0

Source: U.S. Department of Agriculture, Chickens and Eggs, Production, Disposition and Income, SRS, Pou 2-3, 1966

Appendix Table 3 -- Egg Production in the United States by Regions, 1950, 1955, 1960, 1965

Region		Production							
		1950		1955		1960		1965	
		Million Eggs	Per-cent	Million Eggs	Per-cent	Million Eggs	Per-cent	Million Eggs	Per-cent
1	Boston	2,747	4.7	2,783	4.7	2,652	4.3	2,800	4.3
2	Philadelphia	9,744	16.5	9,996	16.8	9,302	15.1	8,693	13.5
3	Chicago	10,789	18.3	10,409	17.5	9,712	15.8	8,696	13.6
4	Kansas City	11,204	19.0	10,504	17.6	9,664	15.8	7,117	11.2
5	Minneapolis	7,694	13.1	8,391	14.1	7,414	12.1	5,742	8.9
6	Portland	1,780	3.0	1,946	3.3	2,118	3.4	2,063	3.2
7	Los Angeles	3,469	5.9	4,404	7.4	5,678	9.2	8,016	[illegible]
8	Denver	1,193	2.0	1,015	1.7	955	1.6	932	1.4
9	Ft. Worth	3,971	6.7	3,078	5.2	3,034	4.9	3,032	[illegible]
10	Memphis	3,561	6.0	3,240	5.4	4,865	7.9	8,640	[illegible]
11	Atlanta	2,802	4.8	3,760	6.3	6,097	9.9	8,660	13.4
	United States	58,954	100.0	60,526	100.0	61,491	100.0	64,391	100.0

Source: U.S. Department of Agriculture, Chickens and Eggs, Production, Disposition, and Income, SRS, Pou 2-3, 1966

U.S. Department of Agriculture, Chickens and Eggs: Layers, Potential Layers, Rate of Lay and Egg Production, 1964-65, SRS, Pou 204. 3-66.

Appendix Table 4. -- Milk Production in the United States by Regions, 1950, 1955, 1960, 1965

Region		Production							
		1950		1955		1960		1965	
		Million Pounds	Per-cent	Million Pounds	Per-cent	Million Pounds	Per-cent	Million Pounds	Per-cent
1	Boston	4,085	3.5	4,502	3.7	4,617	3.8	4,783	3.8
2	Philadelphia	19,874	17.0	21,914	17.8	22,544	18.4	23,330	18.7
3	Chicago	22,057	18.8	22,492	18.3	20,236	16.4	20,674	16.6
4	Kansas City	15,101	13.0	14,730	12.0	13,495	11.0	12,595	10.1
5	Minneapolis	25,964	22.3	28,468	23.1	30,989	25.2	32,597	26.1
6	Portland	4,761	4.1	5,059	4.1	5,234	4.3	4,840	3.9
7	Los Angeles	5,991	5.1	7,241	5.9	8,075	6.6	8,488	6.8
8	Denver	2,393	2.1	2,473	2.0	2,635	2.2	2,693	2.2
9	Ft. Worth	5,442	4.7	4,698	3.8	4,348	3.5	4,346	3.5
10	Memphis	7,055	6.1	7,083	5.8	6,181	5.0	6,100	4.8
11	Atlanta	3,889	3.3	4,285	3.5	4,430	3.6	4,442	3.5
	United States	115,592	100.0	122,945	100.0	122,784	100.0	124,888	100.0

Source: U. S. Department of Agriculture, Milk Production and Dairy Products, Annual Statistical Summary, SRS DA 3, 1966

Appendix Table 5. -- Pork Production in the United States by Regions, 1950, 1955, 1960, 1965

Region		Production							
		1950		1955		1960		1965	
		Thousand Pounds	Per-cent	Thousand Pounds	Per-cent	Thousand Pounds	Per-cent	Thousand Pounds	Per-cent
1	Boston	38,549	0.2	45,539	0.3	46,945	0.3	37,374	0.2
2	Philadelphia	378,331	2.2	388,044	2.2	382,389	2.1	360,526	2.0
3	Chicago	5,287,824	30.4	5,358,163	30.0	5,948,269	32.0	5,597,859	31.3
4	Kansas City	6,835,584	39.4	7,121,785	39.8	6,954,545	37.4	7,176,293	40.1
5	Minneapolis	2,584,435	14.9	2,974,263	16.7	2,735,375	14.8	2,571,612	14.3
6	Portland	157,560	0.9	144,298	0.8	171,938	0.9	168,793	0.9
7	Los Angeles	144,664	0.8	107,370	0.6	90,220	0.5	72,744	0.4
8	Denver	145,628	0.8	80,878	0.5	120,777	0.6	110,811	0.6
9	Ft Worth	495,023	2.8	363,149	2.0	360,517	2.0	306,910	1.7
10	Memphis	796,585	4.6	638,985	3.6	850,011	4.6	700,811	3.9
11	Atlanta	523,587	3.0	627,896	3.5	684,336	4.7	832,501	4.6
	United States	17,392,682	100.0	17,848,736	100.0	18,847,312	100.0	17,936,234	100.0

Source: U S Department of Agriculture, Meat Animals: Farm Production, Disposition, and Income SRS, MtAn 1-1, Table 8, (Marketings).

[illegible] the United States [illegible]

Market Center	1965 Thousand Head
Boston	
Philadelphia	116
Chicago	2,083
Kansas City	6,562
Minneapolis	1,595
Portland	888
Los Angeles	2,282
Denver	2,104
Ft. Worth	1,354
Memphis	186
Atlanta	285
United States	17,593

U.S. Department of Agriculture, *Cattle on Feed Report*, SRS (MtAn 2-1 (1-66)), January, 1966

Appendix Table 7 -- Nutrient Composition of Feedstuffs

	Soybean Oil Meal 44% (01)	Solvent Cottonseed Meal 41% (02)	Solvent Linseed Meal (03)	Peanut Oil Meal (04)	Coconut Meal (05)	Meat and Bone Scrap (11)
Energy (Meg.Cal./lb)						
Metabolizable	1.020	1.000	.692	1.134	.799	.871
Net	.796	.717	.717	.760	.705	.653
Productive	.761	.720	.571	.656	.585	.874
Protein - Percent						
Crude	46.000	43.000	35.000	47.000	21.200	20.000
Digestive	42.000	33.300	29.500	40.300	18.000	40.800
Amino Acids - Percent						
Arginine	3.470	3.650	2.800	4.150	10.400	3.150
Lysine	2.960	1.530	1.300	1.450	.500	3.060
Methionine	.630	.550	.500	.370	.300	.580
Meth & Cystine	1.300	1.280	1.100	.970	.300	1.150
Tryptophan	.480	.480	.500	.410	.200	.310
Glycine	2.450	1.850	----	2.040	----	6.570
Crude Fiber - Percent	7.000	13.000	9.000	13.000	11.200	2.500
Minerals - Percent						
Calcium	.250	.150	.400	.200	.210	10.000
Total Phosphorus	.600	1.000	.830	.600	.640	5.000
Available Phosphorus	.180	.300	.27	.180	.19	5.000
Vitamins						
Niacin (Mg/lb)	12.200	20.700	13.600	77.300	11.300	21.400
Riboflavin (Mg/lb)	1.000	21.100	1.310	5.000	1.400	2.100
Pantothenic Acid (Mg/lb)	6.400	8.100	8.070	24.100	3.000	1.500
Vitamin B_{12} (Mcg/lb)	.900	----	----	----	----	57.000
Choline (GM/lb)	1.247	1.300	5.558	.900	.417	.990
Vitamin A (thousand IU)	----	----	----	----	----	----
Xanthophyll	----	----	----	----	----	----

	Tankage 50% (12)	Blood Meal 80% (13)	Steamed Bone Meal (14)	Poultry By-Product Meal (14)	Feather Meal Hyd (16)	Stabilized Animal Fat (17)
Energy (Meg.Cal./lbs)						
Metabolizable	1.198	1.420		1.258	1.078	3.500
Net	.658	.552		----	.620	2.900
Productive	.814	1.000		.900	.600	2.900
Protein - Percent						
Crude	58.300	79.000	7.500	58.000	87.400	
Digestive	50.800	56.700		47.100	61.200	
Amino Acids						
Arginine	3.600	2.350		3.600	3.920	
Lysine	4.000	4.550		3.500	1.050	
Methionine	.300	.650		.950	.350	
Meth & Cystine	1.000	1.650		1.0	2.350	
Tryptophan	.700	.720		----	.400	
Glycine	----	2.950		----	4.760	
Crude Fiber - Percent	1.900	1.000	1.500	2.500	1.500	
Minerals - Percent						
Calcium	6.370	.280	30.140	3.000	.200	
Total Phosphorus	3.230	.280	24.530	1.700	.750	
Available Phosphorus	3.230	.280	14.530	1.700	.750	
Vitamins - Percent						
Niacin (Mg/lb)	17.800	14.300	1.900	40.000	8.000	
Riboflavin (mg/lb)	1.100	.700	.400	4.000	.900	
Pantothenic Acid (Mg/lb)	1.100	.500	1.100	4.000	3.700	
Vitamin B_{12} (Mcg/lb)	----	20.000	----	129.000	39.000	
Choline (Gm/lb)	.984	.344	----	2.700	.400	
Vitamin A (thousand IU)	----	----	----	----	----	
Xanthophyll	----	----	----	----		

Appendix Table 7. -- Continued

	Fishmeal, Menhaden (21)	Condensed Fish Solubles (22)	Corn Gluten Meal, 41% (26)	Corn Gluten Feed (27)	Hominy Feed 5% fat, yellow (28)	Wheat Bran (29)
Energy (Meg.Cal./lb)						
Metabolizable	1.200	.650	1.177	.766	1.365	.510
Net	.708	---	.790	.689	.845	.569
Productive	.940	.450	.840	.570	.870	.494
Protein - Percent						
Crude	62.100	31.400	42.000	26.600	10.600	16.400
Digestive	50.300	27.900	35.900	22.900	7.500	13.300
Amino Acids - Percent						
Arginine	3.250	1.370	1.170	.480	.480	.650
Lysine	5.100	1.460	.670	.300	.320	.390
Methionine	1.670	.450	.900	.240	.140	.110
Meth & Cystine	2.700	.640	1.440	.540	.260	.270
Tryptophan	.720	.110	.190	.160	.120	.180
Glycine	3.900	2.740	1.350	.720	.280	.560
Crude Fiber - Percent	1.000	.500	4.000	7.200	6.000	10.000
Minerals - Percent						
Calcium	5.000	.100	.100	.460	.050	.140
Total Phosphorus	3.000	.500	.400	.770	.500	1.170
Available Phosphorus	3.000	.500	.120	.210	.150	.350
Vitamins						
Niacin (Mg/lb)	25.400	77.000	22.700	32.700	22.600	95.100
Riboflavin(Mg/lbs)	2.200	6.000	.700	1.100	1.000	1.400
Pantothenic Acid (Mg/lb)	4.000	16.000	47.000	7.800	3.500	13.200
Vitamin B_{12} (Mcg/lb)	84.000	2.000	----	----	----	----
Choline (GM/lb)	1.400	1.400	.150	.689	.435	.049
Vitamin A (thousand IU)	----	1.000	12.000	2.000	1.000	2.000
Xanthophyll	----	----	60.000	12.000	1.600	

	Molasses, Beet (57)	Alfalfa Hay (61)	Timothy Clo (62)	Grass Hay, (64)	Corn Silage (65)	Sorghum Silage (66)
Energy (Meg Cal /lb)						
Metabolizable	9					
Net	.720	.406	.408	.393	.165	[illegible]
Productive						
Protein - Percent						
Crude	8.400	15.000	8.600	6.000	2.100	2.300
Digestive	4.400	10.500	4.700	3.000	.800	.800
Amino Acids - Percent						
Arginine						
Lysine						
Methionine						
Meth & Cystine						
Tryhtophe						
Glycine						
Crude Fiber - Percent		28.800	30.300	27.600	6.400	7.500
Minerals - Percent						
Calcium	.050	1.470	.690	.420	.080	.100
Total Phosphorus	.020	.240	.160	.180	.060	.060
Available Phosphorus						
Vitamins						
Niacin (Mg/lb)	13.200					
Riboflavin (Mg/lb)	1.100					
Pantothenic Acid (Mg/lb)	2.100					
Vitamin B_{12} (Gm/lb)						
Choline (Gm/lb)						
Vitamin A (thousand IU)		13.667	12.667	10.333	8.853	4.500
Xanthophyll						

Appendix Table 7. -- Continued

	Dehydrated Alfalfa Meal 17% (67)	Dried Beet Pulp (71)	Dried Citrus Pulp (72)	Brewers Dried Grains (75)	Distillers Dried Grains (76)	Salt (96)
Energy (Meg Cal/lb)						
Metabolizable	.310	.279		1.144	1.170	
Net	.452	.705	.597	.604	.840	
Productive	.300	.207		.747	.880	
Protein - Percent						
Crude	17.000	8.800	6.200	23.300	26.100	
Digestive	12.300	4.100	2.700	16.800	19.100	
Amino Acids- Percent						
Arginine	.720	.300		1.300	.900	
Lysine	.720	.600		.900	.900	
Methionine	.230	.010		.400	.400	
Meth & Cystine	.550	.015		.460	.450	
Tryptophan	.300	.100		.400	.200	
Glycine	.720	----		----	.500	
Crude Fiber - Percent	26.000	19.600	11.500	15.600	12.800	
Minerals - Percent						
Calcium	1.400	.690	2.040	.290	.090	
Total Phosphorus	.200	.080	.150	.480	.370	
Available Phosphorus	.060	.01		.16	.110	
Vitamins						
Niacin (Mg/lb)	8.700	7.400	9.800	19.7	19.200	
Riboflavin (Mg/lb)	7.300	.300	1.100	.700	1.400	
Pantothenic Acid (Mg/lb)	12.300	.700	5.900	3.900	2.600	
Vitamin B_{12} (Mcg/lb)	5.000	----	----	----	----	
Choline (Gm/lb)	.400	.377	.383	.720	.365	
Vitamin A (thousand IU)	100.000	.167	.167	----	.500	
Xanthophyll	78.000	----	----	----	.800	

Appendix Table 7 -- Continued

	Wheat Standard Middlings (30)	Wheat, Ground, Philadelphia (31)	Oat Mill Feed (32)	Barley Feed (33)	Rice Bran (34)	[illegible] Corn [illegible]
Energy (Meg.Cal.lb)						
Metabolizable	.885		.270		1.000	[illegible]
Net	.695	.8	.240		.567	[illegible]
Productive	.690		.190		.700	[illegible]
Protein - Percent						
Crude	17.200	10.2	4.100		12.400	[illegible]
Digestive	12.300	8.6	2.700		8.400	[illegible]
Amino Acids - Percent						
Arginine	.900	.36	.140		.880	.500
Lysine	.700	.8	.140		.540	.200
Methionine	.200		.070		.220	[illegible]
Meth & Cystine	.400		.130		.310	[illegible]
Tryptophan	.200		.070		.220	[illegible]
Glycine	.400		.140		.900	[illegible]
Crude Fiber - Percent	7.300	2.1	27.0		12.0	[illegible]
Minerals - Percent						
Calcium	.150	.04	.160		.120	.020
Total Phosphorus	.270	.29	.190		1.480	.270
Available Phosphorus	.080	.08	.060		.440	.080
Vitamins - Percent						
Niacin (Mg/lb.)	44.800	12.8	4.600		128.000	12.100
Riboflavin (Mg/lb.)	.900	4.8	.700		1.200	.600
Pantothenic Acid (Mg/lb.)	9.000	2.5	1.500		10.700	2.700
Vitamin B_{12} (Mcg/lb.)	----	----			----	----
Choline (GM/lb.)	.488	1.716	.200		----	.270
Vitamin A (thousand IU)	----		----		----	1.500
Xanthopyll	---		----		----	7.000

Appendix Table 7. -- Continued

	Barley, Ground (38-39)	Oats (40-41)	Milo, Ground (44-45)	Molasses, Cane (56)	Dried Skim Milk (51)	Whey, Dried Whole (52)
Energy, (Meg. Cal./lb)						
Metabolizable	1.205	1.165	1.305	.918	1.140	1.242
Net	.705	.657	.778	.761	.878	.783
Productive	.810	.810	1.100	.710	1.765	.786
Protein - Percent						
Crude	12.000	11.600	10.800	2.900	33.100	12.800
Digestive	10.000	9.000	8.500		29.800	11.500
Amino Acids - Percent						
Arginine	.570	.800	.500		1.100	.300
Lysine	.380	.500	.300		2.300	.900
Methionine	.160	.180	.160		.980	.150
Meth & Cystine	.570	.400	.310		1.400	.460
Tryptophan	.130	.160	.120		.450	.150
Glycine	.380	.500	.360		.200	.700
Crude Fiber - Percent	8.000	11.000	2.200		.600	.200
Minerals - Percent						
Calcium	.060	.090	.030	.800	1.250	.800
Total Phosphorus	.400	.430	.270	.700	1.000	.700
Available Phosphorus	.120	.130	.080	.210	1.000	.210
Vitamins						
Niacin (Mg/lb.)	29.300	8.100	21.300	5.000	5.100	20.900
Riboflavin (Mg/lb)	1.000	.800	.600	9.000	13.600	1.100
Pantothenic Acid (Mg/lb)	3.300	6.600	5.800	1.500	21.700	17.800
Vitamin B_{12} (Mcg/lb)	----	----	----	25.000	11.000	----
Choline (Gm/lb)	.526	.548	.346	.640	.900	.358
Vitamin A (thousand IU)	----	----	----	----	----	----
Xanthophyll	----	----	----	----	----	----

Appendix Table 8.--Cost of Feedstuffs, Dollars Per 100 Pounds, by Regions, 1965

	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	Atlanta
Soybean Meal	3.439	3.448	3.370	3.442	3.484	4.536	4.520	3.393	3.907	3.700	3.899
Cottonseed Meal	3.936	3.672	3.421	3.272	3.828	3.837	3.453	3.321	3.160	2.946	3.314
Linseed Meal	4.078	4.082	3.506	3.574	3.212	4.512	4.667	3.782	4.015	3.717	3.817
Peanut Meal	4.350	4.166	4.568	4.528	4.683	7.003	7.103	4.683	4.793	3.838	3.713
Coconut Meal	4.350	5.965	5.635	5.315	5.435	4.460	3.870	5.230	5.315	5.435	5.900
Meat and Bone Meal	4.565	4.385	4.358	4.375	4.475	4.466	4.511	4.115	4.250	4.491	4.695
Digester Tankage	5.005	5.25	4.593	4.545	4.418	5.885	5.885	4.529	4.688	4.730	5.064
Blood Meal	6.57	6.46	6.319	5.755	6.480	7.095	5.233	5.462	5.117	5.505	4.500
Steamed Bone Meal	4.584	4.395	3.815	4.323	3.892	5.160	4.302	5.492	4.897	4.355	4.500
Poultry-by-Product Meal	5.010	5.897	5.000	5.386	6.088	3.083	5.235	6.598	5.103	5.008	[illegible]
Feather Meal	5.229	6.193	4.373	5.021	4.833	4.637	5.041	6.943	5.401	5.353	[illegible]
Animal Fat	8.139	7.630	7.345	7.575	7.576	9.159	7.733	7.269	7.503	7.315	[illegible]
Fish Meal	8.090	8.076	8.979	8.607	8.531	7.800	7.498	8.610	8.657	8.453	[illegible]
Fish Solubles	3.272	3.255	3.422	3.708	4.284	3.814	3.034	5.574	4.434	4.302	[illegible]
Corn Gluten Meal	4.327	4.363	3.747	3.747	4.105	4.840	4.741	4.191	4.164	3.899	[illegible]
Corn Gluten Feed	2.657	2.709	2.121	2.120	2.455	3.085	3.000	2.592	2.455	2.284	[illegible]
Hominy Feed	2.557	2.660	2.212	2.128	2.548	3.098	2.811	2.583	2.558	2.405	[illegible]
Wheat Bran	2.591	2.606	2.178	2.154	2.077	2.357	2.582	2.430	2.187	2.281	[illegible]
Wheat Middlings	2.660	2.677	2.181	1.934	1.938	2.657	2.394	2.207	2.246	2.337	1.638
Oat Millfeed	1.560	1.518	1.120	1.052	1.196	2.392	2.392	1.507	1.650	1.555	2.000
Rice Bran	2.947	2.775	2.370	2.340	2.530	2.625	2.600	2.635	2.083	1.915	2.289
Corn #2 F O B	2.864	2.428	2.324	2.327	1.885	2.857	2.909	2.357	2.732	2.422	2.539
Corn #2 Farm	2.946	2.329	1.946	1.964	1.803	2.498	2.572	2.273	2.239	2.239	[illegible]
Barley F O B	2.745	2.237	2.208	2.255	2.434	2.650	2.840	2.333	2.903	2.773	[illegible]
Barley Farm	5.999	1.979	1.773	1.916	1.891	2.000	2.396	2.212	1.812	2.037	[illegible]

Appendix Table 8.--Continued

	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. North	Memphis	Atlanta
Oats F O B	2.834	2.764	2.294	2.351	2.000	2.494	2.906	2.906	2.812	2.406	2.834
Oats Farm	2.581	2.400	2.106	2.073	1.607	1.965	2.344	2.322	2.240	2.415	[illegible]
Wheat F.O.B.	3.111	2.415	2.571	2.603	2.304	2.448	2.783	2.305	3.075	3.130	[illegible]
Wheat Farm	3.899	2.263	2.268	2.213	2.353	2.165	2.416	2.238	2.233	[illegible]	[illegible]
Milo F O B	2.666	2.771	2.481	2.036	2.551	2.613	2.531	2.035	2.348	[illegible]	[illegible]
Milo Farm	9.999	1.893	1.769	1.668	1.678	9.999	2.214	1.769	1.832	[illegible]	[illegible]
Skim Milk Dried	14.29	13.96	14.48	14.17	14.42	13.00	14.98	15.00	[illegible]	[illegible]	[illegible]
Whey, Whole Dried	4.850	5.100	4.860	4.880	4.990	4.350	4.750	[illegible]	[illegible]	[illegible]	[illegible]
Molasses Cane	1.122	1.079	1.171	1.214	1.398	1.150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Alfalfa Hay	2.253	1.754	1.271	1.061	1.172	1.159	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Clover-Grass Hay	1.837	1.558	1.192	1.478	1.109	1.175	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Wild Hay	9.999	9.999	9.999	.989	.773	1.094	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Other Hay	1.966	1.356	.785	.824	9.999	.889	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Corn Silage	12.57	12.03	8.72	7.28	8.04	7.45	8.53	[illegible]	[illegible]	[illegible]	[illegible]
Sorghum Silage	10.69	10.21	7.40	6.18	6.82	6.75	7.24	7.24	[illegible]	[illegible]	[illegible]
Alfalfa Meal	2.642	2.591	2.215	2.019	2.142	3.000	3.000	1.997	[illegible]	[illegible]	[illegible]
Beet Pulp	3.460	3.436	3.324	3.352	2.29[illegible]	2.521	2.526	2.747	[illegible]	[illegible]	[illegible]
Citrus Pulp	2.802	2.825	3.085	3.340	3.540	4.475	2.190	3.790	[illegible]	[illegible]	[illegible]
Brewers Grains	2.728	2.675	2.259	2.276	2.345	3.616	2.704	2.731	2.704	[illegible]	[illegible]
Distillers Grains	3.326	3.270	2.873	3.378	3.328	4.543	4.543	3.713	3.568	[illegible]	[illegible]
Brewers Yeast	9.088	8.580	9.990	9.000	9.818	10.340	8.794	9.750	10.000	[illegible]	[illegible]
Urea	4.75	4.75	4.75	4.75	4.75	4.95	4.95	4.75	4.75	[illegible]	[illegible]
Defluorinated Phosphate	2.891	2.991	3.450	3.412	3.500	4.350	4.320	4.100	3.237	[illegible]	[illegible]
Soft Rock Phosphate	1.369	1.269	1.297	1.296	1.347	1.500	1.450	1.347	1.296	[illegible]	[illegible]
Limestone, Feed Grade	.536	.410	.400	.325	.335	.700	.517	.600	.375	[illegible]	[illegible]
Salt and Trace Minerals	2.08	1.84	1.89	1.49	1.50	2.15	1.80	1.47	1.3[illegible]	[illegible]	[illegible]

[illegible]

Soybean Meal (SBOM) [illegible] of weekly quotations in Fe[illegible] lane at $3 60 with other [illegible] December 21, 1965, the pric[illegible] Kansas City, and $71 90 at [illegible] does not report Boston or [illegible]phia [illegible] shown on these two market[illegible] nt the [illegible]

Cottonseed Meal computed the same as soybean meal The Atlanta price is apparently on the high side, yet the price relationship checks with Feed Market News In Feed Market News th prices at Atlanta were $71 50 per ton, Memphis $67 00, Ft. Worth $68 00, and California Mills, $68 00.

Linseed Meal - computed the same as soybean meal, except the L[illegible] Angeles and Memphis prices. The two prices were computed by adding the freight rate to the respective region to the Minneapolis pric[illegible]

Peanut Meal - prices were available in only four regions; Boston, Philadelphia, Memphis, and Atlanta The price at other markets was the Atlanta price plus transportation costs to the respective region

Coconut Meal - prices available only at Boston and Los Angeles Prices in other regions were the Los Angeles price plus transportation cost to the respective regions

Meat and Bone Meal - computed same as soybean meal.

Digester Tankage prices computed same as SBOM except for Philadelphia, Portland and Los Angeles. Prices computed for these regions are the Kansas City price plus transportation

Blood Meal - same as SBOM except Boston, Philadelphia, and Portland Prices at these three were computed by adding transportation to the Kansas City price.

Steam Bone Meal - same as SBOM except for Philadelphia and Portland Prices were computed by adding transportation to the Chicago price.

Poultry-by-Product Meal - same as SBOM except for Philadelphia, Minneapolis, Portland, and Denver. Prices for these four were Memphis plus transportation

Appendix Table E--Footnotes continued.

Feather Meal - same as SBOM.

Animal Fat - same as SBOM except Portland which was the Denver price plus transportation.

Fish Meal, Menhaden 60% - same as SBOM except for Portland and Denver which was the Canadian Herring Price converted to the menhaden equivalent price based on Protein analysis. The price at Los Angeles was the West Coast blended price converted to the menhaden equivalent price. The Ft. Worth price was the Peruvian meal price converted to menhaden equivalent price.

Fish Solubles - same as SBOM except for Minneapolis, Portland, Denver and Memphis. The price at Minneapolis, Portland, and Denver was Los Angeles plus freight. The Memphis price was Boston plus freight.

Corn Gluten Meal - same as SBOM.

Corn Gluten Feed - same as SBOM.

Hominy Feed - same as SBOM except for Minneapolis, Portland, Denver and Ft. Worth. The price at these points was the Kansas City price plus transportation.

Wheat Bran and Wheat Middlings - same as SBOM.

Oat Millfeed - same as SBOM except for Portland, Los Angeles, and Denver. The price at these points was the Kansas City price plus transportation.

Rice Bran - same as SBOM except for Philadelphia, Chicago, Kansas City, Minneapolis, and Denver. The price at these points was the Memphis price plus transportation.

Corn F.O.B. - average price for No. 2 yellow corn quoted in *Grain Market News*, USDA, Consumer and Marketing Service for 1965 except Boston. The Boston price was the Chicago price plus transportation.

Barley F.O.B. - same as F.O.B. Corn.

Barley Farm - same as farm corn, *Ag. Prices* p. 16. Farm barley was not available at Boston so an artificial high price was shown to block its coming into a least cost solution.

Appendix Table 8 - Fo[illegible]

Oats F.O.B. - [illegible] Prices at these points [illegible]

Oats Farm - same as farm corn, Agricultural Prices, [illegible]

Wheat F.O.B. - same as F.O.B. corn, except [illegible] Atlanta. The prices at these points were the Chicago price plus transportation. The Philadelphia price of wheat was the [illegible] the eleven regions. The wheat available was softred eastern winter wheat which had a protein content of 9 percent compared to 13 percent for other regions.

Wheat Farm - same as farm corn. The Boston region had no farm wheat available. A price of $9.99 was used to block entrance into the solution. Agricultural Prices, p. 14.

Milo F.O.B. - same as F.O.B. corn except for Boston, Philadelphia, Chicago, and Minneapolis. The price at these points was the Kansas City price plus transportation. The low F.O.B. price at Denver was for a locally available surplus. A third vector was added at Denver to reflect the price of Milo which exceeded the local surplus.

Milo Farm - same as farm corn except there was no production of Milo at Boston and Portland. Artificial high prices were used to block entrance at these two locations. Agricultural Prices, p. 15.

Skim Milk Dried - same as SBOM. The Memphis price was Kansas City plus freight.

Whey, Dried, Whole - same as SBOM. The Memphis price was Kansas City plus freight.

Molasses Cane - weighted annual average price from U. S. Department of Agriculture Consumer and Marketing Service, Molasses Market News, 1965 Annual Summary.

Alfalfa Hay - season average price received by farmers, Agricultural Prices, p. 31.

Clover-Grass Hay - season average price received by farmers Agricultural Prices, p. 32, none produced at Los Angeles and Ft. Worth. Artificial high prices used to block entrance into the solution.

Corn Silage and Sorghum Silage prices were derived by the method shown in Appendix 10.

Appendix [illegible] Footnotes contin[illegible]

Alfalfa [illegible] - 17 percent Dehy[illegible]

Beet Pulp, Dried - same as SB[illegible]

Citrus Pulp same as SB[illegible] for [illegible] Angeles, Memphis, and Atlanta. The pri[illegible] Lakeland, Florida, price (Florida Canner[illegible]) transportation

Brewers Grains same as SBOM except f[illegible] Denver The price at these two points wa[illegible] transportation

Distillers Grains - same as SBOM for Bo[illegible] Chicago, Memphis and Atlanta. The prices is ot[illegible] Chicago plus transportation

Brewers Yeast same as SBOM except for [illegible] The price at these two points was the Kansas C[illegible] transportation

Urea - Simple average price of monthly [illegible] of ingredients with stable prices. Urea pri[illegible] delivered east of the Rockies, and higher w[illegible] Prices quoted with equalized freight.

Defluorinated Phosphate - same as Urea

Soft Rock Phosphate - same as Urea.

Limestone, Feed Grade - price is based on prices farmers pay for limestone as a fertilizing material *Agricultural Prices*, p. 167.

Salt Average price paid by farmers, *Agricultural Prices*, p. 163.

[illegible] Table 9.--[illegible] Calculating Equivalent Value of Silages
[illegible] Prices

Based on Grain Price

(1) Price ($/ton)=Average [illegible] grain[a] ($/bu) x average yield (bu/acre)[b]
[illegible] yield silage (t/acre)[b]

Based on Hay Price

Dry Matter

(2) Price ($/ton)=Dry matter silage ( )[3] x price of hay ($/ton)[1]
Dry matter hay (2) [c]

Net Energy

(3) $$\text{Price (\$/ton)} = \frac{\text{Net energy silage}}{\text{Net energy hay}} \times \text{price of hay (\$/ton)}$$

Average of Dry Matter, Net Energy and Protein Ratios

(4) $$\text{Price (\$/ton)} = \frac{\left(\frac{\text{Dry matter silage}}{\text{Dry matter hay}} + \frac{\text{Net energy silage}}{\text{Net energy hay}} + \frac{\text{Protein silage}}{\text{Protein hay}}\right)}{3} \times \text{Price of Hay (\$/ton)}$$

Average of Dry Matter and Net Energy Ratios

(5) $$\text{Price (\$/ton)} = \frac{\left(\frac{\text{Dry matter silage}}{\text{Dry matter hay}} + \frac{\text{Net energy silage}}{\text{Net energy hay}}\right)}{2} \times \text{Price of hay (\$/ton)}$$

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[a] Agricultural Prices, SRS, USDA, Washington, D.C., June, 1964.

[b] Crop Production, 1965 Annual Summary, SRS, USDA, Washington, D.C., December, 1965.

[c] Spencer H. Morrison, "Dry Matter, Net Energy and Protein Values", 1967 Feeds and Feeding Values, Miller Publishing Co., Minneapolis, Minnesota, December, 1967.

Appendix Table 10 --Comparison of Prices Determined by Five Methods of Estimating Silage Prices from Hay and Grain Prices

			METHOD					
Market Center	Farm Value of Grain $/ton	Dry Matter $/ton	Net Energy $/ton	Dry Matter + Net Energy + Protein $/ton	Dry Matter + Net Energy $/ton	Sorghum	Hay	Cost $/ton
Boston	8.93	10.29	15.25	12.79	12.57	10.69		36.74
Philadelphia	6.86	10.00	14.07	9.65	12.03	10.21	Alfalfa	35.08
Chicago	7.76	7.24	10.19	6.69	8.72	7.40	Alfalfa	25.42
Kansas City	6.55	6.05	8.51	5.84	7.28	6.18	Alfalfa	21.22
Minneapolis	7.34	6.68	9.40	6.45	8.04	8.82	Alfalfa	23.44
Portland	7.20	6.61	9.30	6.37	7.85	6.75	Alfalfa	23.18
Los Angeles	7.33	7.0	9.98	6.84	8.53	7.24	Alfalfa	24.88
Denver	5.74^{a}	7.09	9.98	6.84	8.53	7.24	Alfalfa	24.88
Ft. Worth	3.52^{a}	7.35	10.34	7.09	8.84	7.50	Alfalfa	25.78
Memphis	4.96^{a}	7.68	11.38	9.54	9.38	7.88	Grass	27.42
Atlanta	6.35	8.99	13.33	11.18	10.98	9.35	Grass	32.12

^{a}Low Corn Yields.

Appendix Table 11,--Characteristics of Population, Number, Race, Per Capita Personal Income, [illegible] of Persons Per Household, Household Income, 1965

	Population				Percent of Population		Per Capita Personal Income			Average No.[e] Person Per Household		Household Income[f]	
	Percent of Total	Total[a] 000	White[b] 000	Non White[b] 000	White %	Non White %	Total dol.	White[d] $	White[d] $	White No.	Non White No.	White $	Non White $
Boston	5.8	11,145	10,860	285	97.4	2.6	2,925	3,012	2,186	3.25	3.55	9,790	7,760
Philadelphia	24.7	47,590	42,379	5,211	89.1	10.9	3,003	3,142	2,106	3.22	3.67	10,117	7,729
Chicago	19.3	37,275	34,007	3,268	91.2	8.8	2,934	3,017	2,203	3.28	3.68	9,896	8,107
Kansas City	5.7	10,949	10,367	582	94.7	5.3	2,657	2,713	1,881	3.12	[illegible]	[illegible]	[illegible]
Minneapolis	4.7	9,040	8,858	182	98.0	2.0	2,630	2,646	1,817	3.36	[illegible]	[illegible]	[illegible]
Portland	3.3	6,307	6,124	183	97.1	2.9	2,753	2,786	1,711	3.12	3.87	[illegible]	[illegible]
Los Angles	9.5	18,403	16,913	1,472	92.0	8.0	3,352	3,352	2,307	3.02	3.45	[illegible]	[illegible]
Denver	3.3	6,296	5,951	345	94.5	5.5	2,519	2,633	1,331	3.36	4.32	[illegible]	[illegible]
Ft Worth	6.8	13,039	11,472	1,567	88.0	12.0	2,329	2,535	1,292	3.27	3.60	[illegible]	[illegible]
Memphis	7.9	15,146	10,917	4,229	72.1	27.9	1,919	2,987	990	3.38	4.12	[illegible]	[illegible]
Atlanta	9.2	17,672	13,236	4,436	74.9	25.1	2,227	2,604	1,155	[illegible]	[illegible]	[illegible]	[illegible]
	100.0	192,862	171,102	21,760	88.7	11.3							

[a] U. S. Department of Commerce, Statistical Abstracts of the United States, 1967, p. 12

[b] U. S. Department of Commerce, Statistical Abstracts of the United States, 1967, p. 29

[c] U. S. Department of Commerce, Statistical Abstracts of the United States, 1967, p. 243

[d] Ratio of White and Non White Median Income (U S. Dept of Commerce, Census of Population 1959, Volume 1, Characteristics of Population, Part I, U S Summary, Table 138, p 1-258) Total Median Income,, times Per Capita Personal Income for 1965

[e] U. S. Department of Commerce, Census of Population, 1959, Characteristics of Population Part I, U. S. Summary, Table 117, p. 1-262

[f] Per Capita Personal Income Times Average Number of Persons Per Household

Appendix Table 12.--Freight Rates, Dressed Poultry Unfrozen Between 11 Origins and Destinations, Refrigerated Rail Car (Cents Per 100 Pounds)

Origin	Destination										
	Boston (a)	Philadelphia (a)	Chicago (a)	Kansas City (a)	Minneapolis (a)	Portland (a)	Los Angeles (a)	Denver (a)	Ft Worth (a)	Memphis (a)	Atlanta (a)
Boston	---	91^2	160^2	234^6	229^6	252^7	252^7	298^6	179^6	186^3	[illegible]
Philadelphia	91^2	---	148^2	222^6	217^6	252^7	252^7	286^3	161^6	160^3	[illegible]
Chicago	92^7	85^7	---	74^6	69^6	162^9	162^9	138^6	129^6	81^6	101^6
Kansas City	149^6	137^6	74^6	---	78^6	130^9	130^9	84^6	83^6	76^6	106^6
Minneapolis	141^6	135^6	69^6	130^9	---	130^9	137^9	120^6	133^6	102^6	133^6
Portland	252^7	252^7	151^7	130^9	130^9	---	89^8	105^9	151^7	151^7	[illegible]
Los Angeles'	252^7	252^7	151^7	94^6	137^9	89^8	---	105^9	130^9	(151) 433^1	(23[illegible]) 57
Denver	189^6	179^6	138^6	83^6	120^6	105^9	105^9	---	114^6	114^6	141^6
Ft Worth	179^6	161^6	125^6	109^3	119^6	162^9	130^9	114^6	---	84^6	107^6
Memphis	148^6	120^6	115^3	109^3	158^3	162^9	137^9	187^3	80^6	---	60^6
Atlanta	121^6	91^6	112^2	124^2	141^2	232^7	232^7	168^2	122^2	60^6	---

Appendix Table 12.--Continued.

1) 21,000 lb minimum weight
2) 30,000 lb minimum weight
3) 35,000 lb. minimum weight
4) 40,000 lb. minimum weight
5) 45,000 lb. minimum weight
6) 50,000 lb. minimum weight
7) 60,000 lb. minimum weight
8) 75,000 lb. minimum weight
9) 80,000 lb. minimum weight

a) Letter to W. K. McPherson from J. V. Beebl, Chief Traffic Management Branch, Inventory Management Division, ASCS, USDA.

b) Letter to W. K. McPherson from Robert C. Halderman, Senior Transportation Economist, Southern Railway System, Washington, D. C.

Appendix Table 13.—Freight Rates, Fresh Meat, Carcasses, Dressed Between 11 Origins, 11 Destinations, Refrigerated Rail Car (Cents Per 100 Pounds)

	Destination										
Origin	Boston (a)	Philadelphia (a)	Chicago (a)	Kansas City (a)	Minneapolis (a)	Portland (a)	Los Angeles (a)	Denver (a)	Ft. Worth (a)	Memphis (b)	Atlanta (b)
Boston	--	74^5	133^5	237^3	231^3	391^5	391^5	320^3	236^5	380^1	338^1
Philadelphia	74^5	--	121^5	225^3	219^3	379^5	379^5	308^3	185^5	328^1	284^1
Chicago	133^5	121^5	--	104^3	98^3	131^7	131^7	187^3	176^3	115^3	106^7
Kansas City	166^5	153^5	104^3	--	109^3	122^7	117^7	129^3	115^3	109^3	130^5
Minneapolis	157^5	151^5	98^3	109^3	--	115^7	124^7	164^3	181^3	158^3	148^5
Portland	391^5	377^5	131^7	122^7	115^7	--	89^7	101^7	131^7	131^7	233^7
Los Angeles	264^7	252^7	131^7	117^7	124^7	89^7	--	99^7	111^7	287^4	631^1
Denver	211^5	199^5	187^3	130^3	164^3	101^7	99^7	--	155^3	187^3	181^5
Ft. Worth	236^5	185^5	176^3	115^3	181^3	131^7	111^7	155^3	--	88^3	209^1
Memphis	173^2	148^2	115^3	109^3	158^3	390^1	376^1	187^3	168^1	--	76^5
Atlanta	220^1	177^3	182^5	211^3	119^3	262^7					

Appendix Table 13,--Continued

[1] 21,000 lb. minimum weight

[2] 30,000 " " "

[3] 35,000 " " "

[4] 40,000 " " "

[5] 45,000 " " "

[6] 50,000 " " "

[7] 75,000 " " "

[8] 80,000 " " "

a) Letter to W. K. McPherson from J. E. Beahl, Chief, Traffic Management Branch, Inventory Management Division, ASCS, USDA

b) Letter to W. K. McPherson from Robert C. Halderman, Senior Transportation [illegible], Southern Railway System, Washington, [illegible]

Appendix Table 14.--Transportation Rates, Fresh Meat, Carcasses, Rail, USDA Estimates From One Percent Sample of Waybills and Map Coordinates, 1965

Origin	Destination										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	----	0.69	1.70	2.21	2.06	3.46	3.50	2.77	2.57	2.08	[illegible]
Philadelphia	0.69	----	1.43	1.95	1.89	3.35	3.33	2.57	2.30	1.74	[illegible]
Chicago	1.70	1.43	----	1.00	0.87	2.76	2.74	1.80	1.67	1.14	[illegible]
Kansas City	2.21	1.95	1.00	----	1.00	2.49	2.33	1.25	1.10	0.90	[illegible]
Minneapolis	2.06	1.89	0.87	1.00	----	2.42	2.51	1.49	1.73	1.49	[illegible]
Portland	3.46	3.35	2.76	2.49	2.42	----	1.67	1.88	2.61	2.84	3.14
Los Angeles	3.50	3.3	2.74	2.33	2.51	1.67	----	1.67	2.7	2.60	2.93
Denver	2.77	2.57	1.80	1.25	1.49	1.88	1.67	----	1.40	1.74	2.17
Ft. Worth	2.57	2.30	1.67	1.10	1.73	2.61	2.17	1.40	----	1.07	1.56
Memphis	2.08	1.74	1.14	0.90	1.49	2.84	2.60	1.74	1.07	----	0.83
Atlanta	1.82	1.44	1.30	1.45	1.78	3.14	2.93	2.17	1.56	0.83	----

Appendix Table 15 --Transportation Rates, Fresh Meat, Carcasses, Truck, USDA Estimates From One Percent Sample of Waybills and Map Coordinates, 1965

Origin	Destination										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	0.80	1.63	2.21	2.03	4.11	4.17	2.97	2.69	2.04	1.75
Philadelphia	0.80	--	1.36	1.90	1.83	3.91	3.87	2.69	2.32	1.67	1.37
Chicago	1.63	1.36	--	1.01	0.92	2.96	2.93	1.73	1.59	1.11	1.25
Kansas City	2.21	1.90	1.01	--	1.01	2.57	2.36	1.21	1.08	0.94	1.38
Minneapolis	2.03	1.83	0.92	1.01	--	2.48	2.61	1.42	1.66	1.41	1.71
Portland	4.11	3.91	2.96	2.57	2.48	--	1.59	1.82	2.74	3.08	3.55
Los Angeles	4.17	3.87	2.93	2.36	2.61	1.59	--	1.60	2.16	2.72	3.21
Denver	2.97	2.69	1.73	1.21	1.42	1.82	1.60	--	1.34	1.67	2.15
Ft. Worth	2.69	2.32	1.59	1.08	1.66	2.74	2.16	1.34	--	1.06	1.49
Memphis	2.04	1.67	1.11	0.94	1.41	3.08	2.72	1.57	1.06	--	0.89
Atlanta	1.75	1.37	1.25	1.38	1.71	3.55	3.21	2.15	1.49	0.89	--

Appendix Table 16.--Rail Freight Rates, Fresh Eggs (Cents Per 100 Pounds)

Origin	Destination										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	133^{a}	237^{a}	252^{b}	252^{b}	252^{b}	252^{b}	252^{b}	252^{b}	252^{b}	252^{b}
Philadelphia	133^{a}	---	216^{a}	252^{b}	252^{b}	252^{b}	252^{b}	252^{b}	252^{b}	252^{b}	210^{a}
Chicago	237^{a}	216^{a}	---	151^{a}	144^{a}	177^{b}	177^{b}	245^{a}	234^{a}	164^{a}	203^{a}
Kansas City	297^{a}	273^{a}	151^{a}	---	158^{a}	152^{b}	152^{b}	152^{b}	152^{b}	158^{a}	224^{a}
Minneapolis	280^{a}	269^{a}	144^{a}	158^{a}	---	152^{b}	152^{b}	152	152^{b}	216^{a}	255^{a}
Portland	415^{d}	415^{d}	404^{d}	394^{c}	394^{c}	---	169^{c}	366^{a}	394^{b}	394^{c}	404^{d}
Los Angeles	415^{d}	415^{d}	404^{d}	394^{c}	394^{c}	169^{c}	---	366^{a}	394^{c}	394^{c}	404^{d}
Denver	377^{a}	356^{a}	245^{a}	182^{a}	220^{a}	152^{b}	152^{c}	---	213^{a}	245^{a}	304^{a}
Ft. Worth	356^{a}	321^{a}	234^{a}	164^{a}	237^{a}	177^{b}	152^{b}	213^{a}	---	162^{a}	220^{a}
Memphis	293^{a}	252^{a}	164^{a}	152^{b}	177^{b}	177^{b}	152^{b}	152^{b}	152^{b}	---	148^{a}
Atlanta	255^{a}	210^{a}	203^{a}	224^{a}	232^{b}	232^{b}	232^{b}	232^{b}	220^{a}	148^{a}	---

[a] 20,000 pounds minimum weight.

[b] 60,000 pounds minimum weight.

[c] 31,800 pounds minimum weight.

[d] 33,000 pounds minimum weight.

Source: Letter from J.W. Boehl, Chief, Traffic Management Bureau, Inventory Management Division, USDA, ASCS, August 10, 1967.

Appendix Table 17.--Fresh Milk: Transfer Costs Between Eleven Origins and Destinations[a] (Cents per 100 Pounds)

Origin	Destination										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	---	68	174	244	239	508	498	334	310	230	[illegible]
Philadelphia	68	---	139	199	203	472	453	292	262	182	[illegible]
Chicago	174	139	---	100	85	354	354	180	172	103	[illegible]
Kansas City	244	199	100	---	92	313	273	116	103	97	[illegible]
Minneapolis	239	203	85	92	---	289	326	155	173	155	[illegible]
Portland	508	472	354	313	289	---	175	223	340	386	[illegible]
Los Angeles	498	453	334	273	326	175	---	200	237	320	[illegible]
Denver	334	292	180	116	135	223	200	---	143	[illegible]	[illegible]
Ft. Worth	310	262	172	103	175	340	237	237	---	[illegible]	[illegible]
Memphis	230	182	105	97	155	186	310	310	186	---	[illegible]
Atlanta	188	139	131	150	194	442	369	369	243	[illegible]	---

*Transfer Costs (cents per hundred weight) = highway mileage[a] X .16[b] + 20[b]

[a] Standard Highway Mileage Guide, Rand McNally and Company, Chicago, 1961.

[b] David E. Weleschern, Economic Analysis of Competitive Sources of Supply to Florida, Unpublished Masters Thesis, University of Florida, April, 1965.

Appendix Table 18.--Broilers: Feed Cost Per 100 Pounds and Quantities by Regions for Four Iterations

Region	First Iteration		Second Iteration		Third Iteration		Fourth Iteration	
	Quantity[a] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars
Boston	.715	3.40	.001	3.41	.001	[illegible]	[illegible]	[illegible]
Philadelphia	2.734	3.10	4.244	3.11	4.244	[illegible]	[illegible]	[illegible]
Chicago	.320	2.97	3.997	2.97	3.997	[illegible]	[illegible]	[illegible]
Kansas City	.238	2.79	6.757	2.79	6.757	2.79	[illegible]	[illegible]
Minneapolis	.194	2.90	.689	2.91	.689	2.91	.689	[illegible]
Portland	.263	3.46	.001	3.36	.001	3.36	.001	[illegible]
Los Angeles	.454	3.39	.001	3.30	.001	3.29	.001	[illegible]
Denver	.021	3.02	.485	2.98	.485	2.91	[illegible]	[illegible]
Ft. Worth	1.027	3.15	.001	3.17	.001	[illegible]	[illegible]	[illegible]
Memphis	3.648	3.08	.001	3.16	.001	[illegible]	[illegible]	[illegible]
Atlanta	4.563	3.25	.001	3.32	.001	[illegible]	[illegible]	[illegible]

[a] First iteration quantities are based on the actual production of broilers in [illegible]

[b] Cost per 100 pounds - least-cost solution for the given quantity.

[c] Based on the optimum reallocation of production from the cost of the preceding iteration

Appendix Table 19 --Layers: Feed Cost Per 100 Pounds and Quantities by Regions for Four Iterations

Region	First Iteration		Second Iteration		Third Iteration		Fourth Iteration	
	Quantity[a] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars
Boston	932	2.82	1.179	2.86	1.179	2.86	1.179	2.82
Philadelphia	2.895	2.52	5.768	2.52	5.768	2.52	5.768	2.52
Chicago	2.896	2.45	4.052	2.45	4.052	2.44	4.052	2.46
Kansas City	2.370	2.32	1.265	2.31	1.265	2.32	1.265	2.31
Minneapolis	1.912	2.33	1.715	2.28	1.715	2.32	1.715	2.32
Portland	.685	2.85	.001	2.90	.001	2.83	.001	2.80
Los Angeles	2.870	2.86	1.887	2.87	1.887	2.86	1.887	2.87
Denver	.310	2.54	.665	2.45	.665	2.49	.665	2.46
Fort Worth	1.010	2.65	1.458	2.66	1.458	2.68	1.458	2.66
Memphis	2.877	2.56	1.587	2.57	1.587	2.56	1.587	2.56
Atlanta	2.884	2.74	1.865	2.74	1.865	2.75	1.865	2.74

[a] Quantities for the first solution are based on the actual production of eggs in 1965.

[b] Cost per 100 pounds - least-cost solution for the given quantity.

[c] Based on the optimum reallocation of production from the cost of the preceding iteration.

Appendix Table 20.--Hogs. Feed Cost Per 100 Pounds and Quantities by Regions for Four Iterations

Region	First Iteration		Second Iteration		Third Iteration		Fourth Iteration	
	Quantity[a] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars
Boston	.112	2.73	.001	2.73	.001	2.75	.001	2.75
Philadelphia	1.052	2.46	13.589	2.55	.001	2.31	13.616	2.62
Chicago	16.794	2.15	10.229	2.14	10.242	2.14	13.215	2.15
Kansas City	21.529	2.03	14.039	1.98	11.648	1.95	14.076	1.98
Minneapolis	7.715	1.97	5.575	1.97	19.100	1.98	2.520	1.95
Portland	.506	2.57	1.787	2.58	1.790	2.57	1.790	2.59
Los Angeles	.218	2.48	4.857	2.69	.001	2.51	4.859	2.63
Denver	.332	2.41	.001	2.27	1.624	2.29	.001	2.33
Fort Worth	.921	2.16	3.698	2.28	.001	2.14	3.698	2.38
Memphis	2.105	2.42	.001	2.14	4.348	2.41	.001	2.27
Atlanta	2.498	2.42	.001	2.19	5.022	2.48	.001	2.20

[a] Quantities for the first solution are based on the actual production of hogs in 1965.

[b] Cost per 100 pounds - least-cost solution for the given quantity.

[c] Based on the optimum reallocation of production from the cost of the preceding iteration.

Appendix Table 21.--Fed Beef: Feed Cost Per 100 Pounds and Quantities by Regions for Four Iterations

Region	First Iteration		Second Iteration		Third Iteration		Fourth Iteration	
	Quantity[a] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars
Boston	.002	2.20	.001	2.20	.001	2.22	.001	2.22
Philadelphia	.278	1.96	10.741	2.03	10.741	1.99	10.738	[illegible]
Chicago	4.999	1.78	8.131	1.73	8.131	1.73	8.129	1.73
Kansas City	15.749	1.72	2.251	1.72	2.254	1.72	2.254	[illegible]
Minneapolis	3.828	1.61	5.100	1.59	8.534	1.58	8.535	1.58
Portland	2.126	1.83	1.365	1.86	1.365	1.86	1.365	1.83
Los Angeles	5.478	2.02	4.122	1.99	4.121	1.98	4.121	1.99
Denver	5.050	1.89	1.291	1.78	1.291	1.88	1.291	1.80
Fort Worth	3.346	1.76	2.679	1.86	2.680	1.73	2.687	1.83
Memphis	.446	1.77	2.861	1.84	2.861	1.88	2.861	1.87
Atlanta	.684	1.94	3.438	2.09	.001	2.06	.001	2.06

[a] Quantities for the first iteration are based on the actual production of fed beef in 1965.

[b] Cost per 100 pounds - least-cost iteration for the given quantity.

[c] Based on the optimum reallocation of production from the cost of the preceding iteration.

Appendix Table 22.--Dairy: Feed Cost Per 100 Pounds and Quantities by Regions for Four Iterations

Region	First Iteration		Second Iteration		Third Iteration		Fourth Iteration	
	Quantity[a] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars	Quantity[c] Billion Pounds	Cost[b] 100 Pounds Dollars
Boston	1.937	2.54	1.937	2.54	1.937	2.54	1.937	2.54
Philadelphia	9.488	2.41	9.449	2.49	9.449	2.43	9.449	2.49
Chicago	8.373	2.09	8.373	2.09	8.373	2.09	8.373	2.09
Kansas City	5.101	2.04	5.101	2.04	5.101	2.04	5.101	2.04
Minneapolis	13.201	1.94	13.202	1.94	13.202	1.95	13.202	1.94
Portland	1.960	2.19	1.960	2.22	1.960	2.30	1.960	2.28
Los Angeles	3.438	2.37	3.438	2.46	3.438	2.46	3.438	2.46
Denver	1.091	2.18	1.091	2.18	1.091	2.11	1.091	2.18
Ft. Worth	1.760	2.07	1.760	2.08	1.760	2.10	1.760	2.08
Memphis	2.371	2.11	2.470	2.20	2.470	2.21	2.470	2.20
Atlanta	1.799	2.38	1.799	2.44	1.799	2.46	1.799	2.44

[a] Quantities for first solution are based on the actual production of milk in 1965.

[b] Cost per 100 pounds - least-cost solution for the given quantity.

[c] Based on the optimum reallocation of production from the cost of the preceding solution.

Appendix 23.--Broilers: Feed Cost Differences (FCD)[a] Using Average Cost of Four Iterations by Regions (Costs Per 100 Pounds)

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-30	-44	-62	-51	-2	-9	-42	-25	-27	-15
Philadelphia	30	--	-14	-32	-21	28	21	-12	5	3	15
Chicago	44	14	--	-18	-7	42	35	2	19	17	29
Kansas City	62	32	18	--	11	60	53	20	37	35	47
Minneapolis	51	21	7	-11	--	49	42	9	26	24	36
Portland	2	-28	-42	-60	-49	--	-7	-40	-23	-25	-13
Los Angeles	9	-21	-35	-53	-42	7	--	-33	-16	-18	-6
Denver	42	12	-2	-20	-9	40	33	--	17	15	27
Ft. Worth	25	-5	-19	-37	-26	23	16	-17	--	-2	10
Memphis	27	-3	-17	-35	-24	25	18	-15	2	--	12
Atlanta	15	-15	-29	-47	-36	13	6	-27	-10	-12	--

[a] Feed cost difference = cost of 100 pounds of diet in consuming region - cost of 100 pounds of diet in producing region; Interpretation - if an element in the producing region row is negative then the cost of feed in the producing region is greater by that amount than in the consuming region.

Appendix 24 --Layers' Feed Cost Differences (FCD) Using Average Cost of Four Iterations (Cents Per 100 Pounds) by Regions

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-32	-39	-52	-51	0	2	-36	-18	-28	-10
Philadelphia	32	-	-7	-20	-21	32	34	-4	14	4	22
Chicago	39	7	--	-13	-14	39	41	3	21	11	29
Kansas City	52	20	13	--	-1	52	54	16	34	24	42
Minneapolis	51	21	14	1	--	53	55	17	35	25	43
Portland	0	-32	-39	-52	-53	--	2	-36	-18	-28	-10
Los Angeles	2	-35	-41	-54	-55	-2	--	-38	-20	30	-12
Denver	36	4	-3	-16	17	36	38	--	18	8	26
Ft. Worth	18	-14	-21	34	-35	18	20	-18	--	10	8
Memphis	28	-4	-11	-24	-25	28	30	-8	10	--	18
Atlanta	10	-22	-29	-42	-43	10	12	-26	-8	-18	--

Appendix 25.--Hogs: Feed Cost Difference (FCD) Using the Average Cost of the Four Locations (Cents Per 100 Pounds) by Regions

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	-	-26	-60	-76	-77	-16	-15	-42	-50	-43	-42
Philadelphia	26	--	-34	-50	-51	10	11	-16	-24	-17	-16
Chicago	60	34	-	-16	-17	44	45	18	10	17	18
Kansas City	76	50	16	—	-1	60	61	54	26	53	34
Minneapolis	77	51	17	1	-	61	62	35	27	34	35
Portland	16	-10	-44	-60	-61	--	1	-26	-34	-27	-26
Los Angeles	15	-11	-45	-61	-62	-1	--	-27	-35	-28	-27
Denver	42	16	-18	-34	-35	26	27	--	-8	-1	0
Ft. Worth	50	24	-10	-26	-27	54	35	8	--	7	8
Memphis	43	17	-17	-35	-54	27	28	1	-7	--	1
Atlanta	42	16	-18	-34	-35	26	27	0	-8	-1	--

Appendix 26 -- Fed Beef. Food Cost Differences (FCD) Using the Average Cost of the Four Iterations (Cents Per 100 Pounds) by Regions

Producing Region	Consuming Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-22	-47	-49	-62	-37	-21	-37	-39	-37	-17
Philadelphia	22	--	-25	-27	-40	-15	1	-15	-17	-15	5
Chicago	47	25	--	-2	-15	10	26	10	8	10	30
Kansas City	49	27	2	--	-13	12	28	12	10	12	32
Minneapolis	62	40	15	13	--	25	41	25	23	25	44
Portland	37	15	-10	-12	-25	--	16	0	-2	0	20
Los Angeles	21	-1	-26	-28	-41	-16	--	-16	-18	-16	4
Denver	37	15	-10	-12	-25	0	16	--	-2	[illegible]	20
Ft. Worth	39	17	-8	-10	-23	2	18	2	--	2	22
Memphis	37	15	-10	-12	-25	0	16	0	-2	--	20
Atlanta	17	5	-30	-32	-44	-20	-4	-20	-22	-20	--

Appendix 27.--Dairy: Feed Cost Differences (FCD) Using the Average Cost of the Four Iterations (Cents Per 100 Pounds) by Regions

Producing Region	Consuming Region Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Boston	--	-12	-45	-50	-60	-29	-10	-38	-46	-36	-11
Philadelphia	12	--	-37	-42	-52	-21	-2	-30	-38	-28	-3
Chicago	45	37	--	-5	-15	16	35	7	-1	9	34
Kansas City	50	42	5	--	-10	21	40	12	4	14	39
Minneapolis	60	52	15	10	--	31	50	22	14	24	49
Portland	29	21	-16	-21	-31	--	19	-9	-17	-7	-18
Los Angeles	10	2	-35	-40	-50	-19	--	-28	-36	-26	-1
Denver	38	30	-7	-12	-22	9	28	--	-8	12	27
Ft. Worth	46	38	1	-4	-14	17	36	8	--	10	35
Memphis	36	28	9	-14	-24	7	26	-2	-10	--	25
Atlanta	11	3	34	39	-49	18	-4	-27	-35	-25	--

Appendix Table 28.--Broilers: Feedstuffs Required to Meet Nutrient Specifications by Regions, Independent Formulation (Million Pounds), 1965.

Feedstuff	Region Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Fort Worth	Memphis	Atlanta
Soybean Meal	.27152	.93672	.06276	.05888	.03984	.01980	.01527	.00374	.19062	.97269	.97069
Cottonseed Meal			.01601	.00621	.00278	.01314	.02274	.00103	.05134	.28244	.22814
Meat Meal			.01601			.00869	.00565	.00103	.05134	.28244	
Blood Meal							.01657			.09174	.09169
Feather Meal			.00087	.00042	.00484	.00657	.01137		.00059	.00309	.11407
Animal Fat	.00715	.02734	.00320	.00238	.00184	.00263	.00455	.00021	.00027	.05649	.34563
Fish Meal		.02434				.01971	.03411			.01056	
Fish Solubles	.04865		.00641								
Gluten Meal	.00132	.03544	.05191	.02910		.00911	.02224	.00236	.12509	.62354	.42510
Wheat Bran					.00353						
Wheat Middlings					.00311						
Rice Bran	.01484		.01089	.00334	.01499			.00003	.00953	.25303	.29465
Corn F.O.B.	.37646	.39860	.16535	.02383	.10707	.02628	.04548	.00207	.10267	.88569	1.49569
Wheat F.O.B.						.03871	.05373	.00336			
Milo F.O.B.				.11618		.10578	.19249	.00710	.49168		
Cane Molasses	.05577	.13669	.01601			.01514	.02274			.28244	.22814
Alfalfa Meal				.00044	.01044						.22511
DL Methionine	.00007	.00083			.00009	.00004	.00008				.00132
Vitamin A	.00446	.02642				.00220	.00328	.00004	.00151		
Riboflavin	.09409		.01749	.02938			.00811			.37244	.20274
Pantothenic Acid	.00126										

Appendix Table 28 --Continued.

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Choline		.00180	00012		00021	.00018	.00041	.00001	.000042	.04631	
Vitamin B_{12}	.04199	12550	.00442	.01469	.00456			.00032	.01644	.00343	.00323
Rock Phosphate	.01295	.04839	.00044	00490	00338			.00005	.00274	.00776	.08505
Limestone	.00210	00578	00114	00058		.00001	.00481	.00013	.00367	.01925	.02944
Salt	00465	.01777	.00282	.00155	.00155	00171	.00296	.00008	.00667	.02672	.02966

Appendix Table 23.--Broilers: Feedstuffs Required to Meet Nutrient Specifications by Regions, Independent Formulation (Billion Pounds) 1965.

Feedstuff	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
	Region										
Soybean Meal	.26003		.05779	.04914	.03837	.01680	.04515	.00373	.19436	.94428	1.05169
Cottonseed Meal			.01601	.01115		.01314	.02274	.00103	.05134	.28244	.22814
Meat Meal	.01885		.01601	.00745		.00798	.00259	.00103	.05134	.20790	
Poultry-by-Product Meal		.00225	.00225								
Feather Meal					.00465	.00632	.01137	.00021		.03625	.05713
Animal Fat	.00715	.09527	.00409	.00238	.00194	.00263	.00455		.01027	.05649	.34563
Fish Meal					.00804	.01971	.03411			.16726	
Fish Solubles	.02146	.09527	.00409				.00193				.04664
Corn Gluten	.00894	.02288	.03178	.02568	.00915	.00328	.01030	.00235	.12276	.37198	.50397
Rice Bran	.00390	.00435	.00813	.00256	.00293			.00003	.00983	.30306	.17588
Corn F.O.B.	.07153	.72503	.14037	.02383	.11117	.02628	.04548	.00207	.10267	3.22389	.45627
Milo F.O.B.	.34433			.11479		.03971	.19579	.00718	.49107		1.26149
Alfalfa Meal				.00049	.00152			.00006		.00868	.28769
Wheat F.O.B.		.95284	.04433			.12474	.07155	.00327			
DL Mehtionine	.00011	.00055	Trace		.00001	.00007	.00008	Trace			.00064
Rock Phosphate	.00725	.05028	.00022	.00223	.00179		.00096	.00005	.00274		.08920
Limestone	.00231	.00973	.00146	.00074	.00113	.00042	.00523	.00007	.00365	.03034	.02833
Salt	.00465	.01777	.00282	.00155	.00155	.00171	.00296	.00013	.00667	.03672	.02966

Appendix Table 30 --Broilers: Feedstuffs Required to Meet Nutrient Specifications by Regions, First Iteration (Million Pounds), 1965

Feedstuff	Region									
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.26003	.01460	.06114	.05457	.05001	.01889	.03980	.00373	.19062	.94428	.84875
Cottonseed Meal		.03844	.01549	.01192		.01314	.02274	.00103	.05134	.28244	.22814
Peanut Meal											.08270
Meat Meal		.11683	.01601			.00846	.00493	.00103	.05134	.20789	
Blood Meal											.11853
Feather Meal			.00106		.00484	.00657	.01137		.00059	.03625	
Animal Fat	.00715	.02734	.00320	.00238	.00193	.00263	.00455	.00021	.01027	.05649	.04563
Fish Meal	.02146				.00180	.01971	.03412			.16726	
Fish Solubles		.08201	.00961	.00497			.01310				
Corn Gluten Meal	.00896	.01951	.02927	.02673	.01207	.00175	.01472	.00225	.12503	.37198	.54835
Rice Bran	.00390	.02521	.01116	.00008	.01206				.00963	.30306	.01358
Corn F.O.B.	.07153	.85986	.17715	.02383	.01935	.02628	.04548	.00207	.10267	3.22389	.45627
Barley F.O.B.						.02062		.00037			
Milo F.O.B.	.34433			.11743		.10483	.25610	.00705	.49168		2.21878
Wheat F.O.B.		.76229				.03693		.00321			
Alfalfa Meal				.00067	.00037	.00118		.00007		.00868	
D. L. Methionine	.00011	.00053				.00008	.00003				.00033
Rock Phosphate	.00725	.00875	.00031	.00479	.00323			.00005	.00274		.09373
Limestone	.00231	.01207	.00157	.00066	.00082	.00027	.00540	.00007	.00367	.03034	.01170
Salt	.00393	.01504	.00176	.00131	.00106	.00145	.00250	.00011	.00565	.03107	.02510
Corn Minneapolis					.09169						

Appendix Table 31 --Broiler: Feedstuffs Required to Meet Nutrient Specifications by Regions, Second Iteration (Million Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	[illegible]
Soybean Meal	.00037	1.19971	1.02660	1.61361	.17802	.00011	.00010	.10757	.00021	.00018	.00022
Animal Fat	.00001	.04244	.03997	.06757	.00689	.00001	.00001	.00485	.00001	.00001	.00001
Fish Meal	.00001	.12544			.00641	.00007	.00007		.00002	.00005	.00001
Fish Soluble	.00003	.12732	.11991	.04045			.00002				
Gluten Corn Meal	.00001	.01884	.37302	.79616	.04298	.00001	.00003	.04632	.00010	.00005	.00006
Rice Bran	.00001	.08967	.16361	.06509	.04293			.00555	.00001	.00006	.00002
Corn F.O.B.	.00010	1.79291	2.24551	.67570	.06890	.00010	.00010	.04850	.00010	.00059	.00010
Milo F.O.B.	.00049			3.30098		.00041	.00057		.00050		.00051
Rock Phosphate	.00002	.05286	.07539	.13818	.01149		.00000	.00989	.00002	.00001	.00002
Limestone	.00000	.02050	.01517	.01445	.00292	.00001	.00001		.00000	.00001	.00000
Salt		.02334	.02198	.03716	.00379	.00000	.00257				
Cottonseed Meal		.15435	.05770	.24102		.00005	.00005	.02425	.00005	.00005	.00005
Wheat F.O.B.		.78343				.00016					
D.L. Methionine		.00037			.00014			.00004			
Feather Meal		.02486	.02486		.01722	.00002	.00002			.00001	.00002
Alfalfa Meal				.08554	.00131			.04027			
Corn Minneapolis					.32640						
Barley F.O.B.						.00003					
Milo (Denver)								.23768			

Appendix Table 32.--Broilers Feedstuffs Required to Meet Nutrient Specifications by Regions, Third Iteration (Billion Pounds), 1965

Feedstuff	Regions										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	Atlanta
Soybean Meal	.00037	1.17144	1.02680	1.56486	.17802	.00011	.00010	.10291	.00020	.00018	[illegible]
Cottonseed Meal		.16523	.05770	.31426		.00005	.00005	.02425	.00005	.00005	[illegible]
Peanut Meal											[illegible]
Blood Meal									.00002	.00001	[illegible]
Feather Meal			.02486		.01722	.00002	.00002			.00001	[illegible]
Animal Fat	.00001	.04244	.03997	.06737	.00689	.00001	.00001	.00485	.00001	.00001	[illegible]
Fish Meal	.00001	.13347			.00641	.00007	.00007	.00584		.00004	
Fish Solubles	.00003	.12732	.11891	.12052			.00002				
Gluten Meal	.00001	.01763	.37502	.77048	.04298	.00001	.00003	.04690	.00012	.00005	.00005
Rice Bran	.00001	.08491	.16361	.01534	.04293			.00195	.00001	.00006	
Corn F.O.B.	.00010	1.84133	2.24551	.67570	.06890	.00010	.00010	.04850	.00010	.00058	.00057
Corn (Minneapolis)					.32640						
Barley F.O.B.						.00003					
Wheat F.O.B.		.73272				.00016		.07980			
Milo F.O.B.	.00049			3.32315		.00041	.00056		.00049		
Milo (Denver)								.17410			
Alfalfa Meal				.01993	.00131			.00237			
Rock Phosphate	.00002	.05122	.07538	.13626	.01148			.00761	.00002	.00001	.0000[illegible]
Limestone		.02088	.01517	.01834	.00292	.00001	.00001	.00147		.00001	.00001
Salt	.00001	.02334	.02138	.03716	.00379	.00001	.00001	.00267	.00001	.00001	.00001

Appendix Table 33 --Broilers Feedstuffs Required to Meet Nutrient Specifications by Regions. Final Iteration (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	Atlanta
Soybean Meal	.00037	1.03063	1.02378	1 58240	17802	00011	00010	.54172	.00021	.00018	.00022
Cottonseed Meal		21220	.06350	12223		.00005	.00005	.12765	.00005	.00005	.00005
Feather Meal			.04331	.00827	.01722	00002	.00002			.00001	.00002
Animal Fat	00001	.04244	.03997	04688	00689	.00001	00001	.02553	.00001	.00001	00001
Fish Meal	00001	.17694			00641	.00007	.00007	03075	.00002	.00005	00001
Fish Solubles	.00003	12732	.11991				.00002				
Gluten Meal	00001	.00983	33473	57239	.04298	00002	.00003	.24687	.00010	.00005	.00006
Rice Bran	00001	.13191	.15737	.06568	.04293			.01028	.00001	.00006	.00002
Corn F.O.B.	00010	2 15318	2.26034	.46880	.06890	00010	.00010	.25530	.00010	.00059	00010
Corn (Minnesota)					.32640						
Milo F.O.B.	.00049			2 28532		.00043	00057		.00050		.00051
Milo (Denver)								91644			
Alfalfa Meal, Dhyd.				.00866	.00131			01250			
Wheat F.O.B.		.39706				.00016		42006			
Rock Phosphate	00002	.04242	.07431	09634	01149			04532	.00002	.00001	00002
Limestone		.02281	.01597	01135	00292	.00001	00001	.00771		.00001	
Salt	.00001	02334	.02198	02578	.00378	00001	00001	01404	00001	.00001	.00001

Formulation (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.21409	.36581	.39685	.40740	.37677			.03408	.12428	.39548	.01[illegible]46
Blood Meal						.01717	.10965				.20000
Fish Meal						.01969	.13347				
Fish Solubles							.20595				
Gluten Meal			.15559					.02392	.09853	.20476	.30730
Wheat Middlings					.14045						
Oat Feed	.01847										
Rice Bran					.02633				.00731	.21335	.37[illegible]
Corn F.O.B.	.54282	.96908	1.59085	.23700	1.15537	.06870	.26693	.03104	.10097	1.81701	1.5[illegible]
Barley F.O.B.		.80251	.18576			.04304					
Wheat F.O.B.				1.03903			1.55841	.13566	.51611		
Cane Molasses	.04660	.14474	.14479			.03435	.13347		.05048	.14886	.14[illegible]
Alfalfa		.07237	.07239	.05925	.04780	.01717	.06673	.01837	.02524	.07193	.07209
Brewers Grains			.07578	.52483			.00939				
DL Methionine	.00039	.00246	.00106	.00020	.00083	.00055	.00133	.00011	.00027	.00074	.00074
Vitamin A	.00964										
Riboflavin	.08518		.21978	.18190	.14824		.09189		.08034	.21550	.21059
Choline		.22679	.00051			.00079		.00014	.00021	.00109	.00262
Vitamin B_{12}	.07446	.00034	.22933	.18945	.14971			.02354	.08017	.22783	.16739
Rock Phosphate	.03412	.01606	.10779		.07095	.00791	.06367	.01164	.03812	.10333	.09902
Limestone	.04246	.11519	.11384	.09390	.08661	.03308	.13076	.01210	.4466	.11616	.13521
Salt	.00326	.01013	.01013	.00829	.00669	.00240	.00934	.00109	.00353	.01017	.01009

Appendix Table 35.--Layers: Feedstuffs Required to Meet Nutrient Specifications by Regions, Simultaneous Formulation (Billion Pounds), 1965.

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.20968	.41610	.40410	.54291	.38453			.03000	.21567	.55585	.34771
Peanut Meal											.0816
Meat Meal						.01782		.03104			
Feather Meal							.06952				
Fish Meal						.02929	.13347				
Fish Solubles							.14353				
Corn Gluten Meal				.01360							[illegible]
Wheat Bran	.03938				.09348						
Rice Bran										[illegible]	[illegible]
Corn F.O.B.	.54730	1.31992	1.52350	.23700	1.19181	.06693	.26693	.03104	.10097	1.[illegible]	[illegible]
Barley F.O.B.		.65954	.65380			.11323					
Milo F.O.B.				1.11776			1.22672	.16577	.55945		[illegible]
Wheat F.O.B.						.39249	.29725				
Cane Molasses	.04660										
Alfalfa Meal Dhy	.00926	.07237	.07239	.05925	.07801	.01717	.06673	.03879	.04688	.18553	.23516
Brewers Grains				.27086			.25905				
Rock Phosphate	.03413	.10752	.10764	.08627	.06976	.01247	.06468	.00056	.03774	.10533	.10832
Limestone	.04218	.11704	.11707	.08431	.08664	.03333	.13093	.01293	.04478	.12795	[illegible]
Salt	.00326	.01013	.10104	.00825	.00669	.00740	.00934	.00209	.00353	.01007	[illegible]

Appendix Table 36 --Layers: Feedstuffs Required to Meet Nutrient Specifications by Regions, First Iteration (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	[illegible]
Soybean Meal	.20230	41609	.41624	.52215	39735			00338	.18337	.57546	38725
Meat Meal						06735		.03104			
Feather Meal						01301	06673				.05224
Fish Meal						.00350	.13347				
Fish Solubles							.08008				
Corn Gluten Meal							03978	.00805	02790		.06861
Wheat Bran					08475						
Rice Bran	.03038									.10307	08499
Corn F.O.B	.55635	1 51892	1 52044	.23700	.19121	.06870	26693	.16757	.10086	1,78726	1.67026
Barley F.O.B		.65954	.65977			17163		.04567			
Milo F.O.B				1.31232		20807	1.44124		55929		17546
Wheat F.O.B						.09505		.00251			
Cane Molasses	03148										
Alfalfa Meal	.02330	07237	07239	07293	04780	.01717	06673	03583	.03610	13952	16856
Brewers Yeast							34505				
D. L. Methionine	00040	.00212	00212	.00113	.00087	00064	.00049	.00018	.00042	00124	00154
Rock Phosphate	03416	10752	10756	02854	.06970		.06719	00057	.03789	10524	.10462
Limestone	.04929	11704	11708	12487	.10205	03876	14945	01215	.05303	.15199	.15271
Salt	.00419	01303	01303	01067	00860	00309	.01201	.00140	00454	.01295	.01298
Corn Minneapolis					.95945						

Appendix Table 37 --Layers Feedstuffs Required to Meet Nutrient Specifications by Regions, Second Iteration (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	Atlanta
Soybean Meal	.19372	.44503	.52694	.52216	.39733	.00790	.04996	.06523	.22253	.57544	.42093
Wheat Bran	.04319				.09475						
Rice Bran	.00073	.01594	.06102							.10307	.10661
Corn F.O.B.	.58031	1.56154	1.67649	.23700	.19120	.06870	.26690	.03100	.10100	1.78718	1.62746
Alfalfa Meal	.02330	.07237	.07240	.07293	.04780	.01717	.06672	.01671	.03108	.13551	.16250
D. L. Methionine	.00043	.00198	.00160	.00113	.00087	.00039	.00112	.00015	.00048	.00124	.00182
Rock Phosphate	.03398	.10726	.10654	.08854	.06970	.01753	.06891	.01159	.03773	.10323	.10302
Limestone	.05001	.11715	.15508		.10205	.03253	.14952	.01206	.05322	.15198	.15402
Salt	.00419	.01303	.01303		.00860	.00309	.01201	.00140	.00454	.01295	.01298
Barley F.O.B.		.56026	.27944								
Milo F.O.B.				1.31234		.22985	1.53614		.55927		
Corn Minneapolis					.95940						
Feathers Meal						.01717	.06672				.01230
Fish Meal						.03435	.13345				
Oats F.O.B.						.14290					
Wheat F.O.B.						.11641					
Fish Soluble							.08007				
Gluten Corn Meal							.02561				
Wheat Middlings							.21171				
Milo Denver								.17183			

Appendix Table 38 --Layers: Feedstuffs Required to Meet Nutrient Specifications by Regions, Third Iteration (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	[illegible]
Soybean Meal	24506	82909	81961	27871	.33764	.00002		.12788	.32123	.31742	.21810
Peanut Meal											.05808
Feather Meal						.00002	.04717				.04662
Fish Meal						.00005	.09435				
Gluten Meal							.03079				.02112
Wheat Bran	.05717				.03507						
Wheat Middlings					.11871						
Rice Bran	.00092									.05685	
Corn F.O.B.	.73410	3.02852	2.11538	12650	17150	.00010	.18870	.20299	.14580	.98584	.8041
Corn (Minneapolis)					.86810						
Barley F.O.B.		1.31418	.94256			.00001					
Oats F.O.B.						.00016					
Wheat F.O.B.						.00017		.08715			
Milo F.O.B.				.70047		.00036	.96962		.80734		.42266
Milo (Denver)								.15374			
Alfalfa Meal	02347	.14420	00088	.03833	.04287	00002	.04717	.03922	04487	.07696	.11820
Brewers Grain							.34750				
Rock Phosphate	.04298	.21424	.15035	.04726	06352	.00003	.04863	02470	.05447	.05805	.06838
Limestone	06326	.23321	.20129	.06565	.06883	00006	10417	.02594	07682	.08383	00839
Salt	00531	.02596	.01325	00569	00772	.00000	00849	00259	.00656	.00214	.00839

Appendix Table 39 --Layers' Feedstuffs Required to Meet Nutrient Specifications by Regions, Fourth Iteration (Million Pounds), 1965

Feedstuff	Regions										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	Atlanta
Soybean Meal	.25592	.88668	.81045	.27871	.35278	.00001	.01181	.07702	.32123	.31742	.25423
Feather Meal						.00002	.04717				.04662
Fish Meal						.00005	.09435				
Fish Solubles							.05661				
Gluten Meal							.03830	.04484			.01497
Wheat Bran					.07538						
Wheat Middlings					.02285		.15499			.05685	.06770
Rice Bran	.03844	.03175	.14516							.05685	.06770
Corn F.O.B	.70379	3.11122	2.51709	.12650	.17150	.00010	.18870	.16134	.14580	.98584	1.19695
Corn (Minnesota)					.38098						
Barley F.O.B.		2.11625									
Oats F.O.B						.00021					
Wheat F.O.B.						.00017		.08256			
Milo F.O.B				.70047		.00033	1.08401		.80734		
Milo (Denver)								.20064			
Cane Molasses	.03982										
Alfalfa Meal Dhyd	.02847	.14420	.19649	.03893	.04287	.00002	.04717	.04461	.04487	.07696	.10856
Rock Phosphate	.04321	.21371	.14821	.04726	.06371	.00003	.04883	.02496	.05447	.05805	.06675
Limestone	.06235	.23341	.21405	.06665	.08717	.00005	.10570	.02574	.07682	.08383	.09946
Salt	.00531	.02595	.01823	.00569	.00772	.00001	.00849	.00299	.00656	.00714	.00839

Appendix Table 40.--Hogs Feedstuffs Required to Meet Nutrient Specifications by Regions, Independent Formulation (Billion Pounds) 1955.

Feedstuff	Regions										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.01611		2.45840	2.83500	1.08383	.01754	.00680				
Cottonseed		.01218	.12077			.00837	.01394	.02222	.02083	.21024	.09938
Meat Meal						.01766					
Tankage		.08887									
Blood Meal		.00151						.01200	.04879	.05560	.11109
Fish Meal						.00390	.00654	.00997	.02762	.06307	.07492
Hominy	.02242						.00546				
Wheat Middlings			.16000	3.01222			.01908			.03989	
Oat Feed			.36400								
Rice Bran										.33417	.33550
Corn F.O.B.	.04472										
Corn Farm		.21296	10.17834	7.84256	3.52855					.33649	1.05004
Barley F.O.B.	.00008										
Barley Farm		.69600	.17000	.21000	.03505				.18211	.03000	.11600
Oats Farm	.02035		1.10424		2.09866	.12661					.34200
Wheat Farm										.09400	.10400
Milo Farm		.01800	.04600	5.88200	.38400	.33058	.14326	.27355	.57915	.07400	.08800
Cane Molasses	.00561	.05258	.83968	1.07644	.38574		.01091		.04604	.10512	.12487
Alfalfa Hay			.41984					.00831	.00138		.00947
Brewers Grains			.54521				.00653			.05826	
DL Methionine									.00012		
Vitamin A						.00051	.00018				
Riboflavin	.00243	.04994			.21802						

Appendix Table 40.--Continued

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Pantothenic Acid		.00447									
Vitamin B_{12}	.00910	.08713	1.32760	1.75005	.62665	.01749	.01572	.02369	.08741	.15355	.18167
Rock Phosphate	.00055		.14872	.22784	.05636		.00194	.00052			
Limestone	.00159		.17248	.21189	.09548	.00035	.00244	.00384	.00911	.02881	.02706
Salt	.00067	.00631	.06457	.12017	.04629	.00304	.00131	.00199	.00552	.01261	.01498

Appendix Table 41.--Hogs: Feedstuffs Required to Meet Nutrient Specifications by Regions, Simultaneous Formulation (Billion Pounds) 1965.

Feedstuff	Region Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.01611		2.37804	2.82198	.99931		.01924				
Cottonseed Meal		.03532	.13341				.00459	.00517	.00279	.21024	.05094
Meat Meal						.00528	.00340				
Tankage Meal		.08826				.03607		.02851	.06803	.13275	.22942
Poultry-by-Product Meal							.00127				
Hominy	.04424										
Wheat Middlings				1.35333						.09253	
Oat Feed			.14026	.22374							
Rice Bran										.14209	
Corn F.O.B.	.04472										
Barley F.O.B.	.00008										
Milo F.O.B.						.09574		.21893	.38087		
Cane Molasses	.00561									.10512	.12487
Alfalfa Meal Dhy.				.41984	.53822			.00831		.05256	.06244
Brewers Grains										.08010	
Rock Phosphate	.00055		.12268	.18590	.04349						
Limestone	.00159	.00604	.21085	.24616	.11217		.00318	.00158	.00668	.01479	.00704
Salt	.00067	.00631	.06457	.12917	.04629	.00304	.00131	.00200	.00552	.01262	.01459
Oats Farm	.02035		2.7300	2.43716	2.21245	.18690	.03000		.17076	.09400	.34200
Corn Farm		.33055	10.37655	8.22959	3.18864	.09184				1.06147	1.31760
Barley Farm		.56695	.17000	.21000	.71758	.08746	.04546	.06791	.26600	.03000	.11600
Milo		.01800	.04600	5.15153	.38400		.10977			.07400	.08800
Wheat Farm		.01800	.24600	5.15153	.38400		.10977			.07400	.10400

Appendix Table 42.--Hogs: Feedstuffs Required to Meet Nutrient Specifications by Regions, First Iteration (Million Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.01606		2.44582	2.64001	.99589	.02604	.00212	.00472			
Cottonseed Meal		.03544	.13892	.16791		.00770	.00313		.02231	.21054	.10091
Meat Meal						.02532	.00427				
Tankage		.08795									
Blood Meal								.02479	.06794	.13834	.14488
Fish Solubles							.00655				.07492
Wheat Middlings							.00546				
Rice Bran								.03605			
Corn F.O.B.	.04432									.19297	
Barley F.O.B.	.00054	.18808									
Oats F.O.B.	.02046		.36400								
Milo F.O.B.											
Wheat F.O.B.					.24027			.18756			
Cane Molasses	.00561										.10400
Alfalfa Meal			.41984	.53822							.12487
Brewers Grains			.08745					.00831	.00138		.01836
Brewers Yeast							.02182			.15567	
D L Methionine						.00002		.00001	.00001		
Rock Phosphate	.00055		.13048	.20845	.04302						
Limestone	.00160	.00609	.20446	.22819	.11249		.00297	.00209	.00664	.01755	.02209
Salt	.00056	.00526	.08397	.10764	.03857	.00253	.00109	.00166	.00460	.10527	.12487
Hominy	.02242										
Corn Farm		.32722	10.76466	8.35353	3.17100					1.18090	1.23640
Barley Farm	.38345		.17000	.20609	.74920	.05379	.03333	.06720	.26600	.03000	.11600
Milo Farm		.01800	.04600	5.88200	.38400		.10749		.38083	.07400	.08800
Oats			1.93650		2.21965	.15069	.03000		.17093		.34200

Appendix Table 43.--Hogs: Feedstuffs Required to Meet Nutrient Specifications by Regions, Second Iteration (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	Atlanta
Soybean Meal	.00014		1.53548	1.66798	.71670	.18665	.49333				
Hominy	.00020										
Corn F.O.B.	.00035										
Oats F.O.B.	.00018	1.55400	.84928		1.60125	.47774	.03000	.38800			
Milo F.O.B.	.00006					.88687	3.14220		.70899		
Cane Molasses	.00005										
Rock Phosphate			.08310	.13878	.03128	.00915	.04456		.00120		
Limestone	.00001	.12470	.12185	.14692	.08115	.01165	.05729	.00001	.06513	.00002	.00002
Salt		.06794	.05115	.07025	.02788	.00693	.02428		.01849		
Cottonseed Meal		.33951	.04849	.10749		.03237	.12127	.00008	.35840	.00007	.00007
Tankage		.68396						.00004			
Blood Meal		.08900						.00001	.11094	.00002	.00003
Poultry-by-Product		.24415							.05577	.00005	.00003
Fish Meal		.03695				.00139					
Corn Farm		4.44830	6.66308	3.65021	2.18978						
Barley F.O.B.		4.27027									
Barley Farm		.69600	.17000		.53231	.17209			.26600	.00042	.00042
Milo Farm		.01800	.04600	5.88200	.38400		.14600		1.26381	.00042	.00042
Wheat Farm		.40561									
Brewers Grain		.61000									
Oats F.O.B.			.36400								
Alfalfa Meal			.25572	.35122				.00002			
Wheat Middlings				2.03304			.79767	.00016	.12541		
Milo (Denver)								.00067			
Rice Bran									.13570		

Appendix Table 44.--Hogs: Feedstuffs Required to Meet Nutrient Specifications by Regions, Third Iteration (Million Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.00014		1.51978	1.30670	2.52952	.12065					
Cottonseed Meal		.00002	.09058	.14673		.03356	.00002	.02304	.00003	.43480	.14176
Tankage		.00006				.04468		.12110	.00008	.18398	.33410
Blood Meal							.00003			.04367	.15618
Poultry-by-Product							.00004				
Hominy Feed	.00020										
Wheat Middlings				1.94341				.17617		.59515	
Oat Feed			.36400								
Rice Bran										.41341	
Corn F.O.B.	.00035										
Corn Farm			6.7700	1.95872	8.93314					2.31850	3.66390
Barley Farm		.00018	.17000		1.39800	.22530	.00014	.32829	.00049	.03000	.11600
Oats Farm	.00018	.00019	.59269		5.37112	.52562	.00028				.34200
Milo F.O.B.	.00006					.81328					
Milo (Denver)								.91627			
Milo Farm		.00043	.04600	5.88200	.38400		.00043		.00039	.07400	.08800
Wheat Farm										.09400	.10400
Cane Molasses	.00005										.06126
Alfalfa Meal, Dhyd.			.25605	.10814				.04060			.13015
Brewers Grain		.00010	.17615				.00004			.08620	
Phosphate			.08383	.11295	.11084						
Limestone	.00001	.00001	.12086	.12910	.27565	.01179	.00001	.01023	.00001	.05221	.04221
Salt	.00001	.00001	.05121	.05124	.09550	.00985	.00001	.00812	.00001	.02174	.02603

Appendix Table 45.--Hogs - Feedstuffs Required to Meet Nutrient Specifications by Regions, Fourth Iteration (Million Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	00014		1.95352	1.67148	31812	18696	48353				
Cottonseed Meal		.00014	11098	.10768		03242	.12131	.00008	.34157	00007	00004
Tankage		68396						00004			
Blood Meal		08900						.00001	.11094	.00002	.00003
Poultry-by-Product		24120							05871	00005	.00004
Fish Meal		01277				.00139					
Fish Solubles		06391									
Hominy Feed	00020										
Wheat Middlings				2.03766			.79801	00020	21751		
Oat Feed			.36400								
Rice Bran									.03184		
Corn F.O.B.	00035	4.59608									
Corn Farm			8.50611	3.66754	.81328						
Barley F.O.B.		3.99375									
Barley Farm		69600	17000		22252	17238		00002	.26600	.00042	.00046
Oats Farm	00018	1.55400	1.40235		71837	47854	.03000		58800		
Wheat Farm		44000									
Milo F.O.B.	00006					88836	3.14356		1.45054		
Milo (Denver)								.00065			
Milo Farm		01800	04600	5.88200	.38400		14600		54584	00042	00040
Cane Molasses	00005										
Alfalfa Meal Dhyd			33037	35190							

Appendix Table 43.--Continued

Feedstuff	[illegible]										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	[illegible]
Brewers Grain		61000									
Rock Phosphate			.10451	.13904	.01452	.00917	04457		01111		
Limestone	.00001	12847	13969	14720	.03640	.01167	05731	.00001	.05730	.00002	.00001
Salt	00001	.06808	06808	.07038	.01260	00895	.02430	.00001	.01849	.00001	00001

Appendix Table 46.—Fed Beef: Feedstuffs Required to Meet Nutrient Specifications by Regions, Independent Formulation (Million Pounds) 1965.

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft Worth	Memphis	Atlanta
Animal Fat							17960				
Gluten Feed			.01458								
Hominy	00142										
Corn Farm			2.71929	3 20699	2.15169					.06509	.23023
Barley Farm		19012	.17000			.63599					
Wheat Farm						62000	00400			.09400	.11600
Milo F.O.B.							2.05950	3 27167			
Milo Farm		.01800	04400	5.88200	.38400		14600	49800	1.99200	.07400	.08800
Cane Molasses	.00036	.04176	.74988	1.55208		31896	82152		28380	04696	10260
Alfalfa Hay				5.86959		52325	1 34757	1 23356			
Grass Hay		02415	1 23400		1.47782	.13388	00400		1.29583	17462	12838
Corn Silage	.00023										
Urea	00004	00175	09749	03655	05228		05919	00191	03937	.00587	00891
Vitamin A	.00005	00566	10168	.32031	.07786	.04325	11139	.10270	06805	00908	01391
Rock Phosphate			.02891	.05445	01459		.03792	.01483	.01549	.00155	00326
Limestone	.00004	.00224	.01295		02097			.00415	01041	.00120	.00319
Salt	.00001	.00139	02500	07874	.01914	01063	02739	02525	.01673	.00223	.00342

Appendix Table 47.--Fed Beef. Feedstuffs Required to Meet Nutrient Specifications by Regions, Simultaneous Formulation (Billion Pounds) 1965.

Feedstuff	Region									
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	[illegible]
Hominy Feed	00142										
Cane Molasses	00036	.04176				.31896	.82152			.04940	
Barley F.O.B		.01369									
Milo F.O.B							2.19888	3.76980			
Animal Fat							.17339		.01079		
Urea	.00004	00487	.07160	.04589	.05553	.00123	.05221	.00191	03718	.00781	.00881
Rock Phosphate		.00160	.02196	.03798	.01480		03673	.01483	.01291	.00236	00332
Limestone	.00004	00077	03323		02087	.00214		00415	.01800	.00098	.01055
Salt	.00001	.00139	.02500	.07874	.01914	.01063	.02738	.02525	.01573	.00223	.00342
Corn Farm		.15224	3.66290	10 42075	2.52284	.03616			.14000	.24553	.50554
Barley Farm						1.02654					
Oats Farm						.41310					
Milo Farm							.03623		1.47371		
Wheat Farm						.00118					
Clover Grass Hay	.00031										.14545
Grass Hay		.06564	1.18440		1 48153		.58635		1.28352	.17629	
Alfalfa Hay				5 81813		.43892	1.54398	1.23356			
Corn Silage	22023										
Sorghum Silage											.00689

Appendix Table 48.--Fed Beef: Feedstuffs Required to Meet Nutrient Specifications by Regions, First Iteration (Billion Pounds), 1965

	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Animal Fat						.00830	.21300	.10752	.07933		
Milo (Denver)								1.39442			
Milo Farm							.03851	.49800	.88291		
Milo F.O.B.						.19464	2.04700	.74343			
Wheat F.O.B.						.62000					.0247
Cane Molasses	.00035	.04176				.31896	.82152		.31849	.06696	.10200
Rock Phosphate		.00160	.02196	.03798	.01480	.00124	.03738	.01840	.02218	.00232	.00465
Limestone	.00004	.00077	.03324		.02087				.00471	.00066	.00309
Salt	.00001	.00139	.24996	.07874	.11484	.01063	.16430	.02525	.01673	.00223	.00342
Hominy	.00142										
Clover-Grass Hay	.00031										.25387
Corn Silage	.00023										
Urea	.00004	.00487	.07160	.04583	.05553		.03963	.00340	.05786	.00781	.01153
Corn Farm		.15224	3.66330	10.42075	2.52284	.12800		.39000	.74000	.20395	
Barley Farm	.01389										
Grass Hay		.06564	1.16359		1.48153				1.33061	.17698	
Alfalfa Hay				5.81813		.75248	2.11535	1.86308			

Appendix Table 49.--Fed Beef: Feedstuffs Required to Meet Nutrient Specifications by Regions, Second Iteration (Billion Pounds), 1965

Feedstuff	Region Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Hominy	.00059										
Cane Molasses	.00015	1.61100				.20475	.61815			.22520	
Clover-Grass Hay	.00013	.42147									.35003
Corn Silage	.00009										
Urea	.00002	.18795	.09108	.00656	.07396	.00025	.02436	.00049	.04205	.04758	.04685
Limestone	.00002	.01964	.03338		.02780			.00106	.00980	.00900	.04913
Salt		.05370	.04069	.01126	.02550	.00683	.02061	.00645	.01339	.01430	.01718
Soybean Meal		.07376									
Animal Fat		.04326					.11712		.08947		
Corn F.O.B.		5.49929									
Corn Farm		.36770	5.88847	1.49078	3.36049	.12800			.74000	1.66304	2.52918
Grass Hay		2.19200	1.23400		1.97344				1.05428	1.12297	.42869
Rock Phosphate		.07002	.03196	.00543	.01972	.00165	.02502	.00379	.01634	.01394	.01587
Alfalfa Hay			.81825	.83233		.50756	1.57893	.31538			
Milo F.O.B.						.19661	1.73674		.71361		
Milo (Denver)						.39345		.46580			
Milo Farm								.49800			

Appendix Table 50 --Fed Beef. Feedstuffs Required to Meet Nutrient Specifications by Regions, Third Formulation (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Animal Fat		05024					.11712	02732			
Hominy Feed	.00059										
Corn F.O.B.		2 88844									
Corn Farm		2 46404	5 88352	1.49144	5 62631	.12800		12532	.36381	1 77934	.00074
Barley F.O.B.		.02450									
Barley Farm		.69582									
Milo F.O.B.						20251	1 59117				
Milo Denver								.64806			
Milo Farm							.14557		1.45577		
Wheat Farm						.38760					
Cane Molasses	.00015	1.61115				20475	.61825			.10781	
Alfalfa Hay			.81630	.83270		.50764	1 57893	.47805			
Clover-Grass Hay	00013	28255									.00021
Grass Hay		2.19200	1 23400		3.30404				1.02586	1.11497	
Corn Silage	00009										
Sorghum Silage											00001
Phosphate		.06394	.03193	00544	.03301	.00171	.02502	.00471	.00961	.01244	
Limestone	02644			.04655					.01500	.01244	.00002
Urea	00002	.18797		00657	12383	00031	.02436	.00106	.02667	04442	.00001
Salt	.00001	.05371	.04066	01127	.04269	.00683	.02061	.00646	.01344	.01431	.00002
Total	00200	10 74100	8.13100	2 34746	9 17650	1 43937	4.22100	1 29100	2 91020	3 08578	00100

Appendix Table 51.--Fed Beef: Feedstuffs Required to Meet Nutrient Specifications by Regions, Fourth Iteration (Billion Pounds), 1965

Feedstuff	Region Boston	 Philadelphia	 Chicago	 Kansas City	 Minneapolis	 Portland	 Los Angeles	 Denver	 Ft. Worth	 Memphis	 Atlanta
Soybean Meal		.07376									
Animal Fat		.04325				.00324	.11712	.02816	.08975		
Hominy Feed	.00059										
Corn F.O.B.		1.05158									
Corn Farm		5.01600	5.88352	1.49144	5.62631	.12800			.74000	1.75822	.00074
Wheat Farm						.45893					
Milo F.O.B.						.11799	1.73674				
Milo (Denver)								.27645			
Milo Farm								.49800	.71797		
Cane Molasses	.00015	1.61115				.20475	.61815			.12925	
Alfalfa Hay			.81630	.83270		.50765	1.57893	.47710			
Clover-Grass Hay	.00013	.42169									.00021
Grass Hay		2.19200	1.23400		3.30404				1.05741	1.11651	
Corn Silage	.00009										
Sorghum Silage											.00001
Urea	.00002	.18797	.09104	.00657	.12383		.02436	.00011	.04216	.04500	.00001
Rock Phosphate		.07003	.03193	.00544	.03301	.00123	.02502	.00470	.01639	.01271	
Limestone	.00002	.01964	.03338		.04655				.00983	.01181	.00002
Salt	.00001	.05371	.04066	.01127	.04629	.00683	.02061	.00646	.01343	.01431	.00001
Total	.00100	10.74100	8.13100	2.34746	9.17660	1.42865	4.12100	1.29100	2.68700	3.08786	.00100

Appendix Table 52 —Dairy Feedstuffs Required to Meet Nutrient Specifications by Region, Independent Formulation (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	30761	1 65274	.00088		.81619						
Cottonseed Meal							.28852	.04161	.13113	.45129	32187
Blood Meal				20000							
Feather Meal			.14928	.02199		.02873					
Animal Fat				.20404			.13751				
Gluten Feed			1.50760								
Hominy	1.11862										
Wheat Middlings				1.78534	24268		1.20317				
Corn Farm		4 25426	3 92341		2 71666					1.07988	.89267
Barley Farm		69600	.17000			.82105				.03000	.11600
Oats Farm					8.27593						
Wheat Farm		.44000				62000	.00400			.09400	
Milo F O B							45371	.30941			
Milo Farm		.01800	04600	75102	.38400	.13771	.14600	.49800	1.11350	07400	.08800
Cane Molasses	19371	.94486	83730	.51010	.30920	.19602	.34376		.17601	.24705	.17990
Alfalfa Hay			1.59254	65030	1.81741	52937	.60846	.36722	.51288		
Clover Grass Hay	.23518	1.77463	1.23400				36933			75987	.24095
Beet Pulp				82505							
Urea	03874	18897	.16746	10202	26404	03920	06875	.02181	03520	.04941	.03599
Vitamin A	.03940	18897	17030	.10375	.00269	.00133	06992	.02218	03580	05025	.03659
Rock Phosphate		06150	.01954				02864	.00653	.00997	.00135	00248
Limestone	02283									.00263	00237
Salt	01937	02449	08373	05101	.13202	.01960	03438	.01091	01760	02470	C1799

Appendix Table 53.--Dairy: Feedstuffs Required to Meet Nutrient Specifications by Regions, Simultaneous Formulation (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Fort Worth	Memphis	Atlanta
Soybean Meal	.30761	1.69563			.86606						
Cottonseed Meal							.26739	.04161	.21461	.42984	.31284
Animal Fat				.20404							
Feather Meal						.01477					
Gluten Meal				.05045							
Gluten Feed			1.43181							.07579	
Hominy Feed	1.11862										
Wheat Middlings				1.78534							
Barley F.O.B.		.117465									
Milo F.O.B.							2.08238	.30941	.47279		
Wheat F.O.B.						.90331					
Cane Molasses	.19371	.94486		.51010		.19602	.34376			.23526	
Beet Pulp				.80156							
Urea	.03874	.18897	.16746	.10202	.26404	.03920	.66875	.02181	.03520	.04941	.03599
Rock Phosphate		.06486	.01526				.01852	.00653	.00291	.00083	.00205
Limestone	.02383								.00343	.00255	.00594
Salt	.01937	.09449	.08373	.05101	.13202	.01960	.03438	.01091	.01760	.02471	.01799
Corn Farm		4.53317	5.10480		3.87005					1.23551	1.25044
Barley Farm		.12904									
Oats Farm					7.85795						
Milo Farm				.73047				.49800	.51829		
Wheat Farm		.44000				.61882	.00400		.19600		
Alfalfa Hay			2.71931	.66588	2.01320	.69828	.94992	.36722			
Clover Grass Hay	.23518										.25823
Grass Hay		1.88869	.04960				.20765		.56673	.76284	

Appendix Table 54.--Dairy: Feedstuffs Required to Meet Nutrient Specifications by Regions, First Iteration (Million Pounds), 1965

Feedstuff	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
	Region										
Soybean Meal	.50761	1.69616		.05555							
Hominy	1.11861				.55755						
Cane Molasses	.18571			.19602				.54376			2.70
Clover Grass Hay	.25521										
Urea	.05874			.03820	.10202						
Rock Phosphate		.06491	.02079					.06875	.02181	.03520	.04941
Limestone	.02583							.00364	.00579	.00164	.00077
Salt	.01937	.09448	.08575	.01960	.05101	.15202		.03458	.01091	.01760	.02471
Corn Farm		4.55655	5.08761		2.71251	5.52912					.85180
Barley Farm		.28866			.00591						
Wheat F.O.B.		.44000									
Cane Molasses		.94486									
Grass Hay		1.85977	.05041	.25724		.96859		.78400		1.10165	1.52141
Corn Gluten Feed		1.22072			.28688						
Alfalfa Hay			3.10329	.69699	2.25585	5.42748		1.07802	.38166		
Milo Farm				.02119						.72826	
Wheat Bran					.50260			.25577			
Barley Farm				.00391			.87596	.55267			
Oats Farm						6.62165	.44951				
Feather Meal							.00755				
Cottonseed Meal								.48589	.65003	.20659	.42582
Animal Fat								.28008			
Wheat Farm								.00400	.12800	.19600	.06808
Milo (Denver)									.68058		

Appendix Table 55.--Dairy: Feedstuffs Required to Meet Nutrient Specifications by Regions, Second Iteration (Million Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	[illegible]
Soybean Meal	.30759	1.69875		.00340							
Hominy	1.11855			.36066							
Cane Molasses	.19370	.94490									
Clover-Grass Hay	.23520	1.77388			.98862						.10997
Urea	.03874	.18898	.14746	.10202	.26404		.06876	.02182	.03520	.04940	.03598
Limestone	.02383									.00049	.00271
Salt	.01937	.09449	.08373	.05101	.13202		.03438	.01091	.01760	.02470	.01790
Animal Fat		.07348					.38490				
Corn F.O.B.		4.94007									
Wheat Farm		.03439					.00400		.19600	.09400	
Rock Phosphate		.07802	.02095				.00946	.00654	.00164		.00238
Gluten Corn Feed			1.21894	.28866							
Corn Farm			5.10809	2.50698	3.52917		1.13836			1.01091	1.10645
Alfalfa Hay			3.11476	2.25089	5.42756			.36733			.14800
Wheat Bran				.27145			.14420				
Wheat Middlings				.06321							
Barley Farm				.21000		.94191	.36600			.02958	.11558
Oats Farm					6.62176	.12226					
Feather Meal						.00183					
Cottonseed Meal							.51388	.04162	.20658	.37645	.26558
Grass Hay							.79400		1.10155	1.51599	
Milo (Denver)								.80766			
Milo Farm									.72819	.07358	.08758

Appendix Table 56.--Dairy: Feedstuffs Required to Meet Nutrient Specifications by Regions, Third Iteration (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.30759	1.45904			.16220						
Cottonseed Meal							.51386	.03004	.18186	.39695	.31289
Feather Meal					.04860	.01541					
Animal Fat		.12863					.36491				
Gluten Feed			1.21894	.28866							
Hominy Feed	1.11855			.36046							
Wheat Bran				.27220			.14428				
Wheat Middlings				.07636	.32140						
Corn Farm		2.35186	5.10809	2.49878	4.30655					1.18217	1.[illegible]
Barley F.O.B.		2.82673									
Barley Farm				.21000		.88870	.36586		.26551		
Oats Farm					4.75088	.07438					
Milo (Denver)								.18283			
Milo Farm		.01757						.49800	.53585		
Wheat Farm		.44000				.38000	.00400	.12800	.19600		
Cane Molasses	.18370	.94490				.19600					
Alfalfa Hay			3.11476	2.25017	4.77815	.66579	1.13842	.38177	.03136		
Clover-Grass Hay	.23520	1.22386									.256[illegible]
Grass Hay						.41317	.79400		1.01873	1.51722	
Corn Silage					2.22813						
Phosphate		.05416	.02095		.02263			.00579			.00205
Limestone	.02382						.00948			.00053	.00595
Urea	.03874	.18888	.16746	.10202	.24404	.03920	.06874	.02182	.03520	.04840	.03598
Salt	.01837	.09449	.08373	.05101	.13202	.01960	.03438	.01001	.01760	.02470	.01799

Appendix Table 57 --Dairy - Feedstuffs Required to Meet Nutrient Specifications by Regions, Fourth Iteration (Billion Pounds), 1965

Feedstuff	Region										
	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta
Soybean Meal	.30759	1.67392					.51368	.03004	.20658	.37645	.79473
Cottonseed Meal							.36490				
Animal Fat		.04181									
Gluten Feed			1.16060	.34700							
Hominy Feed	1.11855			.36066							
Wheat Bran				.24379			.14420				
Corn F.O.B.		5.11507									
Corn Farm			5.15614	2.53924	3.52589					1.01091	1.08928
Barley Farm				.21000		.94162	.36600			.02958	.11554
Oats Farm					6.62023	.12146					
Wheat F.O.B.						.12427					
Wheat Farm						.16107	.00400	.12800	.19600	.09400	
Milo (Denver)								.68083			
Milo Farm									.72819	.07358	.08760
Cane Molasses	.19370	.94490				.19600					
Alfalfa Hay			3.09362	2.24186	5.38149	.67353	1.13836	.38177			
Clover-Grass Hay	.23520	1.77044									.23977
Grass Hay					1.03743	.37778	.79400		1.10155	1.51599	
Urea	.03874	.18898	.15746	.10202	.26404	.03920	.06876	.02182	.03520	.04940	.03558
Rock Phosphate		.07641	.02276				.00948	.00579	.00164		.00166
Limestone	.20583									.00049	.00648
Salt	.01937	.09449	.08373	.05101	.13202	.01960	.03438	.01091	.01760	.02470	.00799
Feather Meal			.01660		.00509	.01361					

Appendix Table 58.--Synthetic Nutrients: Estimated Utilization by Region and Class of Livestock, Independent Formulation, 1965 (Pounds)

Diet	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portland
BROILER DIET						
Dl Methionine	70,000	830,000			90,000	40,000
Vitamin A	4,460	26,420				
Riboflavin	94,090		17,490	29,380		
Pantothenic Acid	1,260					
Choline		1,800	120	100	210	180
Vitamin B12	41,990	125,500	4,420	14,690	4,560	2,200
LAYER DIET						
Dl Methionine	390,000	2,460,000	1,060,000	200,000	830,000	550,000
Vitamin A	9,640					
Riboflavin	85,180		219,780	181,900	148,240	
Choline		340	510			
Vitamin B12	74,460	226,790	229,330	181,450	149,710	
HOG DIET						
DL Methionine						
Vitamin A						510
Riboflavin	2,430	49,940			218,020	
Pantothenic Acid		4,470				
Vitamin B12	9,100	87,130	1,327,600	1,750,050	626,650	17,490
BEEF DIET						
Urea	40,000	1,750,000	87,490,000	36,550,000	52,280,000	
Vitamin A	50	5,560	101,680	320,310	77,860	43,250
DAIRY DIET						
Urea	38,740,000	188,740,000	167,460,000	102,020,000	264,040,000	39,200,000
Vitamin A	39,400	188,970	170,300	103,750	2,690	1,230

Appendix Table 58 --Continued

Diet	Los Angeles	Denver	Ft Worth	Memphis	Atlanta	Total
BROILER DIET						
DL Methionine	80,000	1,000	1,310		1,320,000	2,431,000
Vitamin A	3,280	40			202,740	238,250
Riboflavin	8,110			372,440		321,510
Pantothenic Acid						1,260
Choline	410	10	420	3,430		6,880
Vitamin B_{12}		320	16,440	46,310	3,230	259,660
LAYER DIET						
DL Methionine	1,330,000	110,000	270,000	740,000	740,000	10,480,000
Vitamin A						9,640
Riboflavin	91,890		80,340	215,500	219,590	1,242,420
Choline		140	210	1,090	2,920	5,210
Vitamin B_{12}		23,540	80,170	227,830	167,390	1,366,460
HOG DIET						
DL Methionine						120,000
Vitamin A	180		120,000			690
Riboflavin						270,390
Pantothenic Acid						4,470
Vitamin B_{12}	57,720	23,690	67,410	153,550	181,670	4,260,060
BEEF DIET						
Urea	59,190,000	1,910,000	39,370,000	5,870,000	8,910,000	293,360,000
Vitamin A	11,390	102,700	68,030	9,080	13,910	953,940
DAIRY DIET						
Urea	68,750,000	21,810,000	35,200,000	49,410,000	35,990,000	1,011,590,000
Vitamin A	69,920	22,180	35,800	50,250	36,590	721,180

Appendix Table 59.—Synthetic Nutrients: Estimated Utilization by Regions and Class of Livestock, Simultaneous Formulation, 1965

Diet	Boston	Philadelphia	Chicago	Kansas City	Minneapolis	Portl
BROILER DIET						
DL Methionine	60,000	550,000	3,000		20,000	70,000
Vitamin A	4,000	23,480				2,670
Riboflavin	11,240			18,580	42,810	
Pantothenic Acid	3,540	1,790				840
Choline		640	200	90	270	370
Vitamin B_{12}	41,880	157,090		5,030		
LAYER DIET						
DL Methionine	420,000	2,120,000	2,020,000	240,000	880,000	[illegible]
Vitamin A	2,790					
Riboflavin	77,920	211,570	212,390	181,410	125,940	
Pantothenic Acid						
Choline			60,000		100	[illegible]
Vitamin B_{12}	73,750	228,960	229,220	184,420	147,070	
HOG DIET						
DL Methionine						
Vitamin A						
Riboflavin	2,430					
Pantothenic Acid		9,860	40,990		279,600	19,360
Choline					1,800	
Vitamin B_{12}	9,100	87,630	1,328,810	1,706,890	627,210	37,190
BEEF DIET						
Urea	40,000	4,870,000	71,600,000	45,890,000	55,530,000	1,230,000
Vitamin A	50	5,660	101,680	320,310	77,860	43,250
DAIRY DIET						
Urea	38,740,000	168,970,000	167,460,000	102,020,000	264,040,000	38,200,000
Vitamin A	39,400	192,180	170,300	103,750	2,690	1,330

Appendix Table 59 - Continued

Diet	Los Angeles	Denver	Ft. Worth	Memphis	Atlanta	Total
BROILER DIET						
DL Methionine	80,000	1,000			640,000	1,424,000
Vitamin A	4,240		1,500			35,890
Riboflavin				375,940	151,560	600,130
Pantothenic Acid	420					6,590
Choline	310	10	400	3,270	2,290	7,800
Vitamin B_{12}		310	16,760		225,750	449,820
LAYER DIET						
DL Methionine	740,000	150,000	490,000	1,260,000	1,150,000	10,000,000
Vitamin A						2,790
Riboflavin		10	66,130	149,770	93,110	1,118,250
Pantothenic Acid						
Choline	330		77,000	200	740	61,500
Vitamin B_{12}				215,960	215,660	1,371,930
HOG DIET						
DL Methionine			10,000			10,000
Vitamin A	220		940			1,160
Riboflavin						301,390
Pantothenic Acid					850	53,500
Choline						
Vitamin B_{12}	11,940	27,010	76,730	170,200	202,230	4,285,640
BEEF DIET						
Urea	52,210,000	1,910,000	37,180,000	7,810,000	8,810,000	287,080,000
Vitamin A	111,390	102,700	66,050	9,080	13,910	853,940
DAIRY DIET						
Urea	68,750,000	21,810,000	35,200,000	49,410,000	35,550,000	1,011,590,000
Vitamin A	69,520	22,180	35,800	50,250	36,550	724,390

Appendix Table 60 —Quantity of Each Diet Required from Reallocation Based on First Iteration Cease

Region	Broiler (Bil/lbs)	Layer (Bil/lbs)	Hog (Bil/lbs)	Beef (Bil/lbs)	Dairy (Bil/lbs)	TOTAL
			Diet			
Boston	.001	1.179	.001	.001	1.937	3.119
Philadelphia	4.244	5.768	13.589	10.741	9.449	43.791
Chicago	3.997	4.052	10.229	8.131	8.373	34.782
Kansas City	6.757	1.265	14.039	2.254	5.101	29.415
Minneapolis	.689	1.715	5.575	5.100	13.202	26.281
Portland	.001	.001	1.787	1.365	1.960	5.114
Los Angeles	.001	1.887	4.857	4.122	3.438	14.305
Denver	.485	.665	.001	1.291	1.091	3.533
Ft. Worth	.001	1.458	3.698	2.679	1.760	9.596
Memphis	.001	1.587	.001	2.861	2.470	6.920
Atlanta	.001	1.865	.001	3.438	1.799	7.104
Total	16.178	21.442	53.778	41.983	50.580	183.961

Appendix Table 61.—Quantity of Diet Required from Reallocation Based on Second Iteration Costs

Region	Diet					
	Broiler (Bil/lbs)	Layer (Bil/lbs)	Hog (Bil/lbs)	Beef (Bil/lbs)	Dairy (Bil/lbs)	TOTAL
Boston	.001	1.179	.001	.001	1.937	3.119
Philadelphia	4.244	5.766	.001	10.741	9.449	30.203
Chicago	3.997	4.052	10.242	3.131	8.373	34.795
Kansas City	6.757	1.265	11.648	2.254	5.101	27.024
Minneapolis	.689	1.715	19.100	8.537	13.202	43.243
Portland	.001	.001	1.790	1.365	1.960	5.117
Los Angeles	.001	1.887	.001	4.121	3.438	9.448
Denver	.485	.665	1.624	1.291	1.091	5.156
Ft. Worth	.001	1.458	.001	2.660	1.760	5.880
Memphis	.001	1.587	4.348	2.861	2.470	11.267
Atlanta	.001	1.865	5.022	.001	1.799	8.688
Total	16.178	21.442	53.778	41.983	50.580	183.961

Appendix Table 52.—Quantity of Diet Required from Reallocation Based on Third Iteration Rates

Region	Diet Broiler (Bil/lbs)	 Layer (Bil/lbs)	 Hog (Bil/lbs)	 Beef (Bil/lbs)	 Dairy (Bil/lbs)	TOTAL
Boston	.001	1.179	.001	.001	1.937	3.119
Philadelphia	4.244	5.768	13.616	10.738	9.449	43.815
Chicago	3.998	4.052	13.215	8.129	8.373	37.767
Kansas City	4.688	1.265	14.076	2.254	5.101	27.384
Minneapolis	.689	1.715	2.520	8.535	13.202	26.661
Portland	.001	.001	1.790	1.365	1.960	5.117
Los Angeles	.001	1.887	4.853	4.121	3.438	14.306
Denver	2.553	.665	.001	1.291	1.091	5.601
Ft. Worth	.001	1.458	3.698	2.687	1.760	9.604
Memphis	.001	1.587	.001	2.861	2.470	6.920
Atlanta	.001	1.865	.001	1	1.759	3.657
Total	16.178	21.442	53.778	41.983	50.580	183.961

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BIOGRAPHICAL SKETCH

Harry Gene Witt was born June 23, 1933, in Lake City, Florida. In June, 1951, he was graduated from Andrew Jackson High School, Jacksonville, Florida. In June, 1955, he received the degree of Bachelor of Science in Agriculture from the University of Florida. From 1955 until 1957 he served in the Field Artillery of the United States Army and was stationed at Fort Sill, Oklahoma. Following his discharge from the army, he enrolled in the graduate school of the University of Florida and received the degree of Master of Science in Agriculture in August, 1959. He worked as an Assistant Maintenance Engineer for American Bakeries at Jacksonville for one year and as an Analytical Statistician with the United States Department of Agriculture from 1960 to 1964. In 1964, he reenrolled in the graduate school of the University of Florida to pursue a program of work towards the degree of Doctor of Philosophy in Agricultural Economics. Since September, 1967, he has been an Assistant Professor of Quantitative Methods at Georgia State University in Atlanta.

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This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Agriculture and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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